Annals
of the
Missouri Botanical Garden

A Quarterly Journal containing Scientific Contributions from the Missouri Botanical Garden and the Graduate Laboratory of the Henry Shaw School of Botany of Washington University in affiliation with the Missouri Botanical Garden.

Information

The Annals of the Missouri Botanical Garden appears four times during the calendar year: February, April, September, and November. Four numbers constitute a volume.

Subscription Price - - - $3.00 per volume
Single Numbers - - - - 1.00 each

The following agent is authorized to accept foreign subscriptions:
Wheldon & Wesley, 2, 3 and 4 Arthur St., New Oxford St.,
London, W. C. 2, England.

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OF THE

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Annals
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Vol. 14 FEBRUARY, 1927 No. 1

A REVISION OF THE GENUS TOWNSENDIA[1]

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History of the Genus

The genus *Townsendia* was first described by William Jackson Hooker in his 'Flora Boreali-Americana' in 1834.[2] It was named in honor of David Townsend of Pennsylvania, an ardent student of botany who contributed substantially to our knowledge of the flora of his native state and especially to the genus *Aster*. Hooker, in establishing the genus *Townsendia*, recognized only one species, *Townsendia sericea*, which he described in detail and carefully illustrated.

Thomas Nuttall,[3] in 1841, added four new species to the genus, namely, *Townsendia incana*, *T. spathulata*, *T. strigosa*, and *T. grandiflora*. The material from which Nuttall described these species was collected by him "on the Black Hills (or eastern chain of the Rocky Mountains) near the banks of the Platte." During the next four decades *T. Parryi* Eaton,[4] *T. condensata* Parry,[5]

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfilment of the requirements for the degree of Master of Science in the Henry Shaw School of Botany of Washington University.

[2] Hook. Fl. Bor. Am. 2: 16. 1834.

[3] Nutt. Trans. Am. Phil. Soc. N. S. 7: 304. 1841.

[4] Eaton, Am. Nat. 8: 212. 1874.

[5] Parry, Am. Nat. 8: 213. 1874.

Issued June 8, 1927

T. scapigera Eaton,[6] *T. Rothrockii* Gray,[7] and *T. Wilcoxiana* Wood[8] were described by individual workers, thus making a total of ten known species. In 1880 Dr. Asa Gray[9] published a synopsis of the group to which he added the following species as new: *T. florifer*, *T. Watsoni*, *T. arizonica*, and *T. glabella*. This synopsis formed the basis for Gray's[10] treatment of the group in the 'Synoptical Flora of North America,' in which seventeen species and four varieties of *Townsendia* were recognized. Since 1886 several species have been published and included in the various manuals treating the flora of portions of the western United States; but no revision of the group as a whole has appeared since Dr. Gray's excellent treatment in the 'Synoptical Flora of North America.'

In 1894 Professor Thomas C. Porter revived Richardson's specific name *exscapus* and created the binomial *Townsendia exscapa* (Richards.) Porter,[11] a name which has been current in botanical literature during the last thirty years.

Through the courtesy of Dr. A. W. Hill, Director of the Royal Botanic Gardens, Kew, England, the writer has been privileged to examine portions of the original material on which the genus *Townsendia* was founded. A critical examination of this material shows that the genus was based on two specifically distinct elements, namely, specimens collected by Dr. John Richardson at "Carlton House upon the Saskatchewan," a plant described in 1823 in "Franklin's Journey to the Polar Sea" as *Aster exscapus* Richards.,[12] and specimens collected in the "Rocky Mountains" by Thomas Drummond. These two plants differ in the following important details: Richardson's specimen has pubescent, linear-lanceolate flat leaves, which overtop the heads, and the pappus of the ray-flower equals that of the disk-flower; Drummond's specimen has more densely sericeous-pubescent subterete leaves equalling but rarely exceeding the head, and the

[6] Eaton, Bot. King's Exp. 145. 1871.
[7] Gray, Wheeler Rept. 6: 148. 1878.
[8] Wood, Bull. Torr. Bot. Club 6: 163. 1875.
[9] Gray, Proc. Am. Acad. 16: 82. 1880.
[10] Gray, Syn. Fl. N. Am., ed. 2, 1[2]: 166. 1886 and 1888.
[11] Porter, Mem. Torr. Bot. Club. 5: 321. 1894.
[12] Richards. Frankl. Jour. Bot. App. 7, 748. 1823.

pappus of the ray-flower is much shorter than that of the disk-flower. The specimens collected by Drummond accord in every detail with the description and illustration in Hooker's 'Flora Boreali-Americana,' while those collected by Richardson present several discrepancies when compared with Hooker's description and illustration, particularly in the character of the leaf, pubescence and pappus. Hence the Drummond plant is interpreted as the type of *Townsendia sericea* Hooker, and this species therefore must be taken as the type or standard species of the genus *Townsendia.* The Richardson plant, on the other hand, becomes the type of *Townsendia exscapa* (Richards.) Porter.

General Morphology

Roots.—Most members of the genus *Townsendia* develop rather slender tap-roots. The roots of some of the more caespitose species, however, become very coarse and woody and more or less branched. The slender tap-root with a simple unbranched crown is typical of the genus.

Stems.—The stem presents considerable variation in length and in the extent to which it becomes branched. *Townsendia Parryi* and *T. formosa* have simple, erect, scapiform stems, while *T. grandiflora, T. texensis,* and *T. strigosa* have numerous ascending branched stems. The stem is usually herbaceous throughout its entire length, but in some species, particularly those of xerophytic regions, the basal portion becomes distinctly ligneous.

Leaves.—The leaf outline varies from linear-lanceolate to obovate-spathulate. In *T. Watsoni* and *T. Parryi* both types are present, the stem-leaves being linear-lanceolate and the basal leaves obovate-spathulate. The broader leaves are attenuated at the base into a petiole, while the narrower ones are only obscurely petiolate or sessile. The range in the leaf size is from 0.5 to 6 cm. in length and from 0.2 to 1.0 cm. in width. Entire leaf margins prevail throughout the genus. The surface is usually pubescent, but sometimes it is glabrate, as in *T. glabella.* In *T. spathulata,* on the other hand, the leaves are villose-lanate. However, a strigose pubescence of closely appressed hairs as in *T. eximia* and *T. strigosa* is most prevalent in the genus.

Inflorescence.—The heads resemble those of the closely related genus *Aster*. They are usually solitary and terminal and may be borne on naked scapes or peduncles, or in the acaulescent forms sessile among the rosulate leaves. In the branched species the heads are occasionally disposed in clusters of two or three, but the solitary condition is most characteristic.

Involucre.—The involucre is broadly campanulate and is composed of two to six series of imbricated bracts. The outline of the bract within the genus is quite variable, ranging from linear-lanceolate to obovate, and from obtuse to acute or acuminate at the apex. A lacerate-ciliate margin prevails throughout the genus. Furthermore, in most species the involucral bracts also have a membranaceous margin. The character of the terminal portion of the bract is important in the natural grouping of species.

Pappus.—The plurisetose pappus consists of a single row of rather coarse, slightly flattened bristles. The pappus of the ray-flower is somewhat shorter, or often reduced to a crown of short squamellae. The pappus in *T. formosa* in both ray- and disk-flowers is scarcely more than a vestige of the squamellate crown. *Townsendia eximia* develops a coroniform pappus of coalescent rigid squamellae sometimes bearing two or more prolonged awns. The condition in *T. eximia* is analogous to that of *T. glabella* where the short ray-pappus contains a few elongated setae. The character of the pappus in some species is very constant, while in others it is exceedingly variable.

Intermediate stages in the length of the ray-pappus from a crown of short setae to a condition in which the setae equal those of the disk-flower in length may be found in *T. incana* and *T. florifer*. The variability in the length of the pappus in certain species, particularly in *T. sericea*, has been emphasized by Gray, Meehan,[1] and others. It is evident that the length of the ray-pappus alone cannot be used in the differentiation of species.

Plate 5.

Corolla and Stamens.—The corolla of the disk-flower equals the involucre in length while the ray is twice as long. The color of the ray varies within the genus from white through pink to

[1] Meehan, Nat. Flowers II. 1: 189. 1880.

purple but is never yellow. In both ray- and disk-flowers the corolla is deciduous. The stamens are typical of the aster group.

Pistil.—The style appendages are lanceolate and have well-developed stigmatic surfaces in both ray- and disk-flowers. Nuttall referred to the ray-flowers of *T. strigosa* and *T. grandiflora* as "infertile or neuter." A ray-flower from Nuttall's type of *T. strigosa* was found to have stigmatic surfaces exactly like those of the disk-flowers, and the ovary contained a well-developed ovule. Flowers were examined from all recorded species, and in all cases the ray-flowers were found to be fertile. Moreover, in those specimens which had reached maturity the ray-achenes were well developed and appeared to be viable.

Achenes.—The achenes are ovate or oblong, much compressed, and calloused margined, although those of the ray are sometimes triangular. The hairs on the achene are bidentate or glochidiate-tipped. These two types have the same morphological origin, the bidentate forms being merely a forerunner of the glochidiate type. The nature of these hairs is best seen under the low power of the compound microscope. The type of pubescence is fairly constant within the species and is important in the classification of the group.

Geographical Distribution

The genus *Townsendia* is restricted in its distribution to the western half of the North American continent. It extends from western Manitoba and southern Alberta west to the Cascade Mountains in Washington and Oregon, southward to the state of Hidalgo in Mexico. *T. mexicana* is endemic to Mexico. The only other representative of the group occurring in that country is *T. strigosa,* a closely related species which extends from Wyoming and Colorado through New Mexico and Arizona into adjacent Mexico. The genus is best represented in Colorado where ten out of the nineteen species recognized in this paper are found. Material at hand would indicate that three of these are endemic to that state. So far as known, *T. leptotes* occurs only in the Middle and South Park Region, *T. glabella* in southwestern Colorado, while *T. Rothrockii* extends from the north-central part of the state to the Uncompahgre Mountains. Two other species

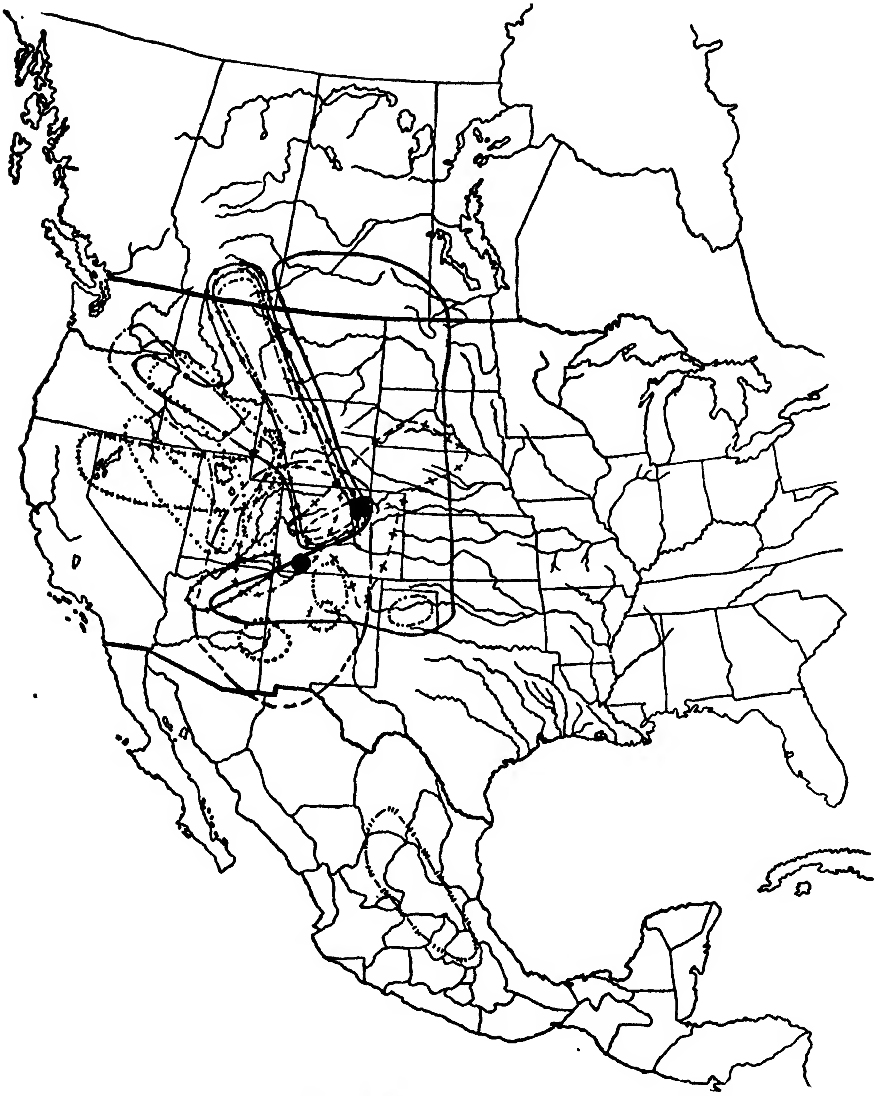


Plate 1. Geographical distribution of the genus *Townsendia*.

Townsendia exscapa.
Townsendia Rothrockii.
Townsendia eximia.
Townsendia montana.
Townsendia sericea.
Townsendia strigosa.
Townsendia mexicana.
Townsendia scapigera.
Townsendia spathulata.
Townsendia florifer.
Townsendia grandiflora.
Townsendia incana.
Townsendia Parryi.
Townsendia Watsoni.
Townsendia arizonica.
Townsendia texensis.
Townsendia formosa.
Townsendia leptotes.
Townsendia glabella.

which seem to be restricted to rather local areas are *T. formosa* of southwestern New Mexico and adjacent Arizona and *T. texensis* of northwestern Texas. The difference between the mountain species *T. sericea* and the plains species *T. exscapa* is very well brought out by material collected in Colorado. The latter has by far the largest distribution of any member of the genus. It extends from western Manitoba and eastern Alberta south through the plains region into Texas, New Mexico, Arizona, and southwestern Colorado. *T. sericea* is found in the Rocky Mountains from Alberta to Colorado and in the Black Hills of South Dakota. Another species which has discontinuous distribution is *T. scapigera* which extends from the Uintah Mountains of Utah to northeastern California and is also found in the region of Santa Fe, New Mexico.

Acknowledgments

The writer is indebted to Dr. George T. Moore, Director of the Missouri Botanical Garden, for the use of the library and herbarium of that institution, and especially to Dr. J. M. Greenman, Curator of the Herbarium, for advice and assistance. Acknowledgements are due to Dr. A. W. Hill, Director of the Royal Botanic Gardens, Kew, England, and to Mr. T. A. Sprague, of the same institution, for the loan of a part of the original material on which this genus was founded. She is also indebted to Mr. D. C. Davies, Dr. P. A. Munz, Dr. Francis W. Pennell, Dr. William R. Maxon, Dr. N. L. Britton, Dr. P. A. Rydberg, Dr. B. L. Robinson, Dr. Edwin B. Payson, and Dr. M. O. Malte, for the loan of material necessary to the study of this genus.

Abbreviations

The specimens cited in this paper are deposited in various herbaria which are indicated by the following abbreviations:

C = National Herbarium of the Victoria Memorial Museum, Ottawa, Canada; F = Herbarium of the Field Museum of Natural History; G = Gray Herbarium of Harvard University; Kew = Royal Botanic Gardens, Kew, England; M = Missouri Botanical Garden Herbarium; NY = New York Botanical Garden Herbarium; Pomona = Herbarium of Pomona College;

Phil = Herbarium of the Academy of Natural Sciences of Philadelphia; R = Rocky Mountain Herbarium; US = United States National Herbarium.

Taxonomy

Townsendia Hook. Fl. Bor. Am. **2**: 16. 1834; DC. Prodr. **7**: 273. 1838; Nutt. Trans. Am. Phil. Soc. N. S. **7**: 304. 1841; Torr. & Gray, Fl. N. Am. **2**: 185. 1842; Benth. & Hook. Gen. Pl. **2**: 268. 1873; Gray, Proc. Am. Acad. **16**: 82. 1880; Syn. Fl. N. Am. **1**^{2}: 166. 1884, and ed. 2, 166. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 156. 1885; Engl. & Prantl, Nat. Pflanzenfam. **4**^{5}: 161. 1890; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 507. 1909; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 691. 1915; Rydb. Fl. Rocky Mts. 873. 1917, and ed. 2, 873. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 553. 1925.

Herbaceous, caulescent or acaulescent, glabrate or pubescent perennials. Leaves alternate, sessile or petioled, linear-lanceolate to obovate-spathulate, entire. Involucre of many imbricated, appressed, lanceolate bracts, usually with lacerate-ciliate membranaceous margins. Heads many-flowered. Ray-flowers numerous, in a single series, pistillate, fertile, rays linear, 2–5-dentate. Disk-flowers tubular, 5-lobed, perfect. Branches of the style lanceolate, acutish, hairy toward the tip. Pappus uniseriate, that of the disk-flower composed of numerous, rather rigid, barbellate-scabrous bristles as long as the corolla; that of the ray-flowers similar or shorter, sometimes squamellate, with a few longer setae intermixed. Achenes of the disk compressed, obovate to oblong; those of the ray sometimes triangular, pubescent with bidentate or glochidiate-tipped hairs, sometimes glabrate.

Type species: *T. sericea* Hook. Fl. Bor. Am. **2**: 16, *pl. 119.* 1834, which was based on the collection of Drummond made in the "Rocky Mountains."

Key to the Species

A. Bracts of the involucre attenuate-acuminate.
B. Stems erect, simple.
C. Pappus plurisetose..*1. T. Parryi*
CC. Pappus a crown of minute squammelate setae............*2. T. formosa*
BB. Stems ascending, branched.
D. Pappus of ray-flower coroniform-concreted; that of disk-flower similar but with two stout awns...........*3. T. eximia*
DD. Pappus in ray-flower a crown of short distinct squamellae; that of disk-flower plurisetose...............*4. T. grandiflora*
AA. Bracts of the involucre acute or obtuse.
E. Leaves glabrous or glabrate.
F. Involucral bracts scarious-margined.
G. Pappus of ray-flower a crown of short squamellae....*5. T. texensis*
GG. Pappus of ray-flower plurisetose......................*6. T. glabella*
FF. Involucral bracts not scarious-margined.............*7. T. Rothrockii*
EE. Leaves persistently pubescent.
H. Achenes glabrous or glabrate..........................*8. T. montana*
HH. Achenes persistently pubescent.
J. Hairs on achenes bidentate.
K. Plants cinereous with short hirsute pubescence.
L. Involucral bracts linear-lanceolate.
M. Leaves all obovate-spathulate................*9. T. Watsoni*
MM. Leaves of stem mostly linear-spathulate........*10. T. florifer*
LL. Involucral bracts broadly lanceolate..........*11. T. scapigera*
KK. Plants densely subsericeous, villous..............*12. T. spathulata*
JJ. Hairs on achenes glochidiate-tipped.
N. Plants with branched ascending stems.
O. Involucral bracts in two series, equal..........*13. T. mexicana*
OO. Involucral bracts in several series, unequal......*14. T. strigosa*
NN. Plants depressed, caespitose.
P. Densely canescent, pubescent.
Q. Leaves 1.5–3 cm. long, narrowly spathulate to oblanceolate.............................*15. T. incana*
QQ. Leaves 1–1.5 cm. long, obovate-spathulate....*16. T. arizonica*
PP. Sparsely hirsute pubescent.......................*17. T. leptotes*
NNN. Plants strictly acaulescent.
R. Leaves narrowly oblanceolate, somewhat glabrate, distinctly flattened.............................*18. T. exscapa*
RR. Leaves linear-lanceolate, densely pubescent, subterete.*19. T. sericea*

1. T. Parryi Eaton, Am. Nat. **8**: 212. 1874; Gray, Proc. Am. Acad. **16**: 82. 1880; Syn. Fl. N. Am. **1**[2]: 167. 1884, and ed. 2, 167. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 156. 1885; Howell, Fl. Northwest Am. 306. 1897; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 508. 1909; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

Stem erect, naked and pedunculiform above, sparingly leafy below, rarely branched, 5–35 cm. high; leaves rosulate, spathulate, often apiculate, tapering into a petiole, 2–5 cm. long, .3–.5 cm. broad; heads solitary, pedunculate or rarely sessile, 3–6 cm. in diameter including the rays; involucre 3–6-seriate; bracts lanceolate, acute, with narrow scarious margins, lacerately ciliate, inner bracts acuminate; rays twice the length of the involucre, blue; pappus the same in ray- and disk-flowers, persistent, plurisetose, a little longer than the achene; achenes pubescent with bidentate hairs.

Distribution: Rocky Mountains from southwestern Canada to Colorado, west to eastern Oregon.

Specimens examined:

Montana: Teton River at the foot of the Rocky Mts., on hard, stony, gravelly plains, May 19, 1854, *Doty 59* (M); bluffs, Midvale, July 4, 1903, *Umbach 254* (F); bluffs, Midvale, June 24, 1903, *Umbach 142* (F); canyon, Helena, July, 1892, *Aiton* (F, No. 90554); Helena, June, 1891, *Kelsey* (F, Nos. 397673 and 397674); Helena, June, 1892, *Starz* (M, No. 713519); mountains about Helena, *Anderson* (M); near Butte, alt. 1846 m., July, 1893, *Mrs. C. H. Moore* (M); rocky canyon, dry ground, Bozeman and vicinity, June 15, 1905, *Blankinship 301* (F); Gallatin Co., May, 1888, *Tweedy 228* (F); mountain meadows, alt. 1537 m., Bozeman, June 1, Livingston, June 8, 1906, *Blankinship 301a* (F, M, R); on a clayey gravelly slope in the foothills ten miles east of Monida, Madison Co., June 18, 1899, *A. & E. Nelson 5425* (M, R); Bridger Mts., June 11, 1897, *Rydberg & Bessey 5132* (F, R); Belt Mts., July 17, 1886, *Anderson* (F, No. 360840); Little Belt Pass, alt. 2154 m., Aug. 10, 1896, *Flodman 828* (M); 1888, *Kelsey* (M, No. 783933); July, 1894, *Mrs. Moore* (M).

Yellowstone National Park: Electric Peak, alt. 2923 m., July 26, 1902, *Smith 16* (F); Mt. Washburn, July 20, 1902, *Smith* (F, No. 121846); Mammoth Hot Springs, June 15, 1902, *Mearns* (F, No. 121848); subalpine, alt. 2923 m., Aug., 1884, *Tweedy* (F, No. 211406); Swan Lake, alt. 2308 m., June, 1885, *Tweedy 695* (F); rocky hills near Mammoth Hot Springs, alt. 1846 m., July, 1893, *Burglehaus* (M); Mt. Washburn, July, 1912, *Eikenberry 59* (F).

WYOMING: Wind River Mts., alt. 2764 m., 1873, *Parry 144* (F, M, *co-type*); Gros Ventres Fork, alt. 2000 m., June 10, 1860, *Hayden* (M); slopes at timber-line, Wyoming Range, 15 miles west of Merna, Sublette Co., July 18, 1922, *E. & L. Payson 2762* (M, R); sage-brush slopes 20 miles west of Big Piney, Sublette Co., July 10, 1922, *E. & L. Payson 2632* (M, R); Gros Ventres Fork, alt. 2400 m., June 5, 1860, *Hayden* (M); in the vicinity of Green River Lakes, Sublette Co., alt. 300 m., Aug. 11, 1925, *E. & L. Payson 4642* (R).

COLORADO: dry ridge near Cottonwood Lake, east of Smoot, Lincoln Co., alt. 3169 m., Aug. 2, 1923, *E. & L. Payson 3693* (M).

IDAHO: dry hillside south of Henry Lake, Fremont Co., alt. 1846 m., July 15, 1920, *E. & L. Payson 2026* (M, R); exposed rocky slopes, base to summit of mountains northeast of Henry Lake, Fremont Co., alt. 2830 m., July 11, 1920, *E. & L. Payson 1979* (M, R).

CANADA: "Moose Mts.," Rocky Mts., alt. 2061 m., June 30, 1897, *Macoun* (F, No. 227891); Mount Forget-me-not, July 16, 1897, *Macoun* (F, No. 227661).

OREGON: subalpine ridges of the Wallowa Mts., alt. 2154 m., July 31, 1899, *Cusick 2295* (F, M, R).

2. T. formosa Greene, Leafl. Bot. Obs. & Crit. **1**: 213. 1906; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts., 508. 1909.

T. pinetorum Greene acc. to Nelson in Coulter & Nelson, Man. Cent. Rocky Mts., 508. 1909, in synonymy.

An herbaceous perennial, spreading by short, stout stolons, the sterile ones ending in a rosette of leaves, the others in a stout upright monocephalous stem about 25 cm. in height; stem striate, sparsely pubescent; leaves thin, glabrous except at the callose-ciliate margin, basal leaves obovate-spathulate, 1.5–4 cm. long, .5–1.5 cm. broad, very obtuse, narrowed below into a sessile or subpetiolate base, those of stem oblong-spathulate, sessile, gradually reduced towards the inflorescence; heads large, 4–6 cm. in diameter including the rays; involucre 2–3-seriate; bracts with broad membranaceous margins, minutely lacerate-ciliate, those

of the outer series broadly ovate, those of the inner series linear-lanceolate, distinctly attenuate-acuminate; achenes glabrous.

Plate 2; pl. 5, fig. 19–24.

Distribution: known only from southwestern New Mexico and adjacent Arizona.

Specimens examined:

New Mexico: Mogollon Mountains on or near the west fork of the Gila River, Socorro County, alt. 2615 m., Aug. 8, 1903, *Metcalfe 413* (M, R); around the south end of the Black Range, Sawyer's Peak, Grant Co., alt. 2770 m., Sept. 30, 1904, *Metcalfe 1434* (M, *co-type*); Sacramento Mts., July 28, 1899, *Wooton* (R).

Arizona: White Mountains, Aug. 6–15, 1903, *Griffiths 5340* (M); Bonita Creek, White Mts., July 23, 1912, *Goodding 1235* (R); Thompsons Ranch, Black River, White Mts., July 13, 1910, *Goodding 561* (R).

3. **T. eximia** Gray, Mem. Am. Acad. (Pl. Fendl.) N.S. **4**: 70. 1849; Walp. Ann. Bot. Syst. **2**: 822. 1851–1852; Syn. Fl. N. Am. **1**^{2}: 167. 1884, and ed. 2, 169. 1886 and 1888; Proc. Am. Acad. **16**: 83. 1880; Coulter, Man. Rocky Mt. Region, 156. 1885; Coulter & Nelson, Man. Cent. Rocky Mts. 508. 1909; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

T. Vreelandii Rydb. Bull. Torr. Bot. Club **28**: 22. 1901; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

Herbaceous perennial, caudex sending up a number of simple or branched stems 15–35 cm. high; leaves spathulate or the upper ones lanceolate, 2–5 cm. long, nearly glabrate; heads terminal, solitary; involucre 3–4-seriate, 1–1.5 cm. broad, 2–3 cm. in diameter; bracts ovate-lanceolate and somewhat cuspidate-acuminate with a narrow membranaceous lacerate-ciliate margin; ray-flowers about 35–40, fertile, blue or purple, with a much-reduced persistent pappus of rigid coroniform-concreted squamellae; pappus of the disk-flowers containing two subulate corneous stout awns which are slightly shorter than the achene; achenes pubescent with glochidiate-tipped hairs, at maturity broadly ovate with a cartilaginous margin. Plate 5, fig. 13–18.

Distribution: mountains of southern Colorado and northern New Mexico.

Specimens examined:

COLORADO: side of Veta Mt., alt. 2600 m., July 19, 1900, *Vreeland 639* (NY, TYPE of *T. Vreelandii*).

NEW MEXICO: Gallinas Valley above the Hot Springs, Las Vegas, Sept. 12, 1881, *G. Engelmann* (M); Las Vegas, Sept., 1881, *G. Engelmann* (M); dry hills and hillsides, Sandia Mts., Balsam Park, alt. 2500 m., July to Aug., 1914, *Ellis 56* (M); La Glorieta, 1879, *Brandegee* (F, No. 204786); Glorieta, 1881, *Vasey* (F, No. 211503); sides of high mountains up Santa Fe Creek, June 28, 1847, *Fendler 353* (M, *co-type*); Santa Fe, 1891, *Alcott* (M, Nos. 890716 and 890499); Canyoncito, Santa Fe Co., alt. 2210 m., June 18, 1897, *A. A. & E. G. Heller 3726* (M); Albuquerque, Sandia Mts., Sept. 6, 1884, *Jones 4157* (F, R); Harvey's Upper Ranch in Pecos River National Forest, alt. 2985 m., Aug. 1, 1908, *Standley 4621* (M); below Winsors Ranch, in Pecos River National Forest, alt. 2550 m., July 19, 1908, *Standley 4412* (M); Rito de los Frijoles, Aug., 1910, *Robbins 8189*, (R).

4. **T. grandiflora** Nutt. Trans. Am. Phil. Soc. N.S. **7**: 306. 1841; Torr. & Gray, Fl. N. Am. **2**: 186. 1842; Gray, Mem. Am. Acad. (Pl. Fendl.) N.S. **4**: 70. 1849; Proc. Am. Acad. **16**: 83. 1880; Syn. Fl. N. Am. **1**²: 167. 1884, and ed. 2, 167. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 156. 1885; Britton, Man. Fl. Northern States and Canada, 944. 1901; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts., 509. 1909; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Rydb. Fl. Rocky Mts. 873. 1917, and ed. 2, 873. 1922.

Caulescent, divaricately branched from the base, 5–20 cm. high; leaves linear, sublanceolate, acute, nearly glabrous, 2–5 cm. long, 0.3–1 cm. broad, two or more of the uppermost usually subtending the head; involucre usually 3-seriate; bracts ovate-lanceolate and rigidly cuspidate-acuminate, with narrow membranaceous lacerate-ciliate margins; heads 1.5–5 cm. in diameter including the rays; pappus of ray-flower reduced to a crown of short squamellae, that of the disk-flower plurisetose, longer than the achene; achenes sparsely pubescent with glochidiate-tipped hairs.

Distribution: eastern South Dakota and Nebraska, west to Wyoming and south to New Mexico; common throughout eastern Colorado.

Specimens examined:

South Dakota: Running Water, Aug. 14, probably 1856, *H. Engelmann* (M); Black Hills on upper Pole Creek, Aug. 1, 1856, *H. Engelmann* (M); Badlands, Cheyenne Valley, Washington Co., July 23, 1911, *Visher 2138* (F).

Nebraska: Warbonnet Canyon, alt. 1532 m., June, 1890, *T. A. Williams* (M); Pine Ridge, July 21, 1889, *Webber* (M); Eaglenest Butte, 1853–4, *Hayden* (M).

Wyoming: stony slopes, Laramie Co., June 29, 1901, *Nelson 8312* (M, R); open sandy slopes south of Sibylee, Albany Co., July 3, 1900, *A. Nelson 7373* (M, R); Corlett, June 24, 1907, *Johnston 253* (M).

Colorado: Douglas Co., 1892, *Walker* (F, No. 376084); Castle Rock, 1889, *Walker* (F, No. 376085); Florence, July 31, 1872, *Brandegee 487* (M); Colorado Springs, July 19, 1872, *Redfield 478* (M); Soldier, June 13, 1899, *Marshall 3138* (F); Garden of the Gods, alt. 2000 m., Aug. 14, 1922, *Brumback & Davis 178* (F); Garden of the Gods, near Colorado City, July 18, 1872, *Porter* (F, No. 318424); Eldorado Springs, alt. 1631 m., June 24, 1917, *Clokey 2810* (F, R); in dry soil, Boulder Canyon, alt. 1692 m., *Young* (F, No. 290193); Colorado Territory, 39–40° lat., alpine and subalpine, 1864, *Parry* (M); Rocky Mts., 40–41° lat., *Vasey 304* (M); infrequent, mesa slopes, Boulder, alt. 1690 m., June 23, 1921, *Hanson C 159* (M); mountains, Larimer Co., alt. 2308 m., June 14, 1896, *Crandall* (M); Una, July 10, 1894, *A. Nelson 385* (M); Platteville, Apr. 17, 1908, *Johnston 492* (M); Horsetooth Gulch, 10 miles southwest of Fort Collins, alt. 1385 m., June 30, 1893, *Baker* (M); Golden, Jefferson Co., July 4, 1915, *Johnston 414 b* (M); foothills near Golden, Castle Rock, July 1, 1885, *Patterson 49* (F, M); foothills near Golden, June 20, 1878, *Jones 284* (F); Gold Hill, Aug. 12, 1875, *Patterson* (F, No. 208980); near Golden City, 1870, *Greene* (F, No. 15363); Fremont Co., near Canyon City, 1873, *Greene* (F, No. 15364); 39–40° lat., alpine and subalpine, 1864, *Parry* (M); Rocky Mts., 40° lat., 1862, *Hall* (F); Rocky Mts., *Hall & Harbour* (F, No. 367351); Rocky Mt.

flora, 39–41° lat., 1862, *Hall & Harbour 289* (F, M); eastern Colorado, *Carleton* (F, No. 353119); southern Colorado, *Brandegee* (F, No. 204740); Manitou, Aug. 11, 1884, *Letterman 83* (M).

New Mexico: low prairie between Orate Creek and Rio Colorado, Aug. 21, 1847, *Fendler 533* (M); Moro River Prairie, Aug. 15, 1847, *Fendler 157* (M).

5. **T. texensis** Larsen, n. sp.[1]

Herbaceous perennial; the caudex giving rise to ascending branched stems 6–30 cm. high, leafy throughout; leaves oblanceolate, 1–5 cm. long, 0.2–0.8 cm. broad, apiculate, narrowed at the base into a petiole, sparsely pubescent with closely appressed hairs, occasionally glabrate; heads usually solitary, terminal, sessile or short-pedunculate, 1.5–3 cm. in diameter including the ray; involucre 4–5-seriate, 1–1.5 cm. in diameter; bracts oblanceolate, acute, pink-tipped, membranaceous-margined and lacerate-ciliate; ray-flowers dark blue or purple with a reduced plurisetose pappus scarcely longer than the breadth of the achene; pappus of disk-flowers plurisetose, somewhat shorter than the corolla; achene pubescent with glochidiate-tipped hairs. Plate 3.

Distribution: northwestern Texas.

Specimens examined:

Texas: Randall Co., "rocky bluffs of the Red River," Aug. 13, 1900, *Eggert* (M, Nos. 121021, type, 121022, 121023); Canyon, Aug. 13, 1900, *Eggert* (M, No. 720398); Randall Co., "rocky banks of the Red River," Aug. 12, 1900, *Eggert* (M, Nos. 121028 and 121027); rocky bluffs of Paloduro, May 30, 1902, *Reverchon 3320* (M); abundant on barren slopes, branch of Paloduro Canyon, Sept. 12, 1917, *Young* (M, Nos. 831212 and 831677); dry

[1] Herbaceis perennis; caule ramoso, ramis ascendentibus, 6–30 cm. altis, foliaceis; foliis oblanceolatis, 1–5 cm. longis, 0.2–0.8 cm. latis, apiculatis, integris, basi in petiolam sensim angustatis, utrinque dense strigoso-pilosis, rarius glabratis; capitulis plerumque solitariis, terminalibus, sessilibus vel brevi-pedunculatis, radio incluso 1.5–3 cm. in diametro; involucris campanulatis, 4–5-seriatis, 1–1.5 cm. in diametro; bracteis involucri oblanceolatis, acutis ad apices roseis, marginibus membranaceis lacerato-ciliatisque; floribus femineis ligulatis, ligulis atro-caeruleis vel purpurascentibus, pappi setis multo reductis vix diametro achenii longioribus; floribus disci numerosis, pappi setis multis paululo corollis brevioribus; acheniis glochideo-pubescentibus.—Collected on "rocky bluffs of the Red River," Texas, Aug. 13, 1900, *H. Eggert* (Mo. Bot. Gard. Herb., No. 121021, type).

open ground, calcareous soil, Channing, Hartley Co., June 19, 1918, *E. J. Palmer 14170* (M); calcareous open ground on plains, Canyon, Randall Co., Oct. 13, 1918, *E. J. Palmer 14586* (M); Canyon, Randall Co., June 12, 1917, *E. J. Palmer 12510* (M).

6. **T. glabella** Gray, Proc. Am. Acad. **16:** 86. 1880; Syn. Fl. N. Am. **1**²: 169. 1884, and ed. 2, 169. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 158. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 510. 1909; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922.

T. Bakeri Greene, Pittonia **4:** 157. 1900.

Subacaulescent; caudex thick, woody, bearing tufted leaves; leaves thick, pilose when young, soon becoming glabrous, linear-spathulate, 2–4 cm. long, 0.2–0.5 cm. broad, gradually narrowed into a slender petiole; heads solitary, on naked peduncles 2–5 cm. long; heads 1.5–2.5 cm. in diameter including the rays; involucre 2–3-seriate; bracts of the involucre oblong, with narrow membranous margins finely lacerate-ciliate; ray-flowers blue or purple, setae irregular, varying in length from 1 to 5 mm.; pappus of disk-flowers regular, as long as the corolla; achenes sparsely pubescent with glochidiate-tipped hairs.

Distribution: known only from southwestern Colorado.

Specimens examined:

Colorado: Pagosa Springs, Aug. 13, 1917, *Payson 1160* (M, R); dry hills, Pagosa Springs, Archuleta Co., alt. 2160 m., June 29, 1921, *Bethel, Willey & Clokey 4340* (F, M, R); hillside near Dix, alt. 2615 m., *Baker, Earle & Tracy 548* (F, M, R); Los Pinos (Bayfield), May 16, 1899, *Baker 727* (F, M, R, type of *T. Bakeri*); mature yellow pine forest, Piedra, June 31, 1924, *Hazel M. Schmoll 1348* (R); open places between pines, Piedra, June 21, 1914, *Hazel M. Schmoll 1212* (R).

7. **T. Rothrockii** Gray, acc. to Rothrock in Wheeler Rept. **6:** 148, *t. 7.* 1878; Gray, Proc. Am. Acad. **16:** 85. 1880; Syn. Fl. N. Am. **1**²: 168. 1884, and ed. 2, 168. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 157. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 510. 1909; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922.

Acaulescent; leaves broadly spathulate, approximately 2 cm. long, glabrous, rosulate; heads sessile, approximately 2 cm. in diameter including the rays; involucre 3–4-seriate; bracts oblong or narrowly ovate, purplish, thickish-margined, distinctly ciliate; ray-flowers with a much-reduced pappus; pappus of disk-flowers equalling or exceeding the length of the corolla; achenes sparsely pubescent with glochidiate-tipped hairs.

Distribution: alpine districts of Colorado.

Specimens examined:

COLORADO: loamy places of the foothills, Sheep and Engineer (?) Mts., Uncompahgre River, alt. 3000–3500 m., Aug. 2, 1893, *Purpus 532* (F); South Park, alt. 4150 m., July, 1873, *Rothrock 875* (F, TYPE); South Park, Aug., 1873, *Rothrock* (F, No. 304922 in part).

8. T. montana Jones, Zoe **4**: 262. 1893; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

T. alpigena Piper, Bull. Torr. Bot. Club **27**: 394. 1900.

T. dejecta Nelson, Bot. Gaz. **27**: 267. 1904; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 510. 1909.

Caespitose from a multicipital caudex; leaves obovate-spathulate, 1–5 cm. long, 0.3–0.5 cm. broad, apiculate, narrowed at the base into a petiole, pubescent in the early stages with appressed strigulose hairs, more or less glabrate; heads 1.5–2.5 cm. in diameter including the rays, sessile or solitary on naked scapes, 1–5 cm. in length; involucre about 3-seriate; bracts of outer series lanceolate, those of the inner series obovate, obtuse, pink-tipped, membranaceous, lacerate-margined; pappus of disk-flowers plurisetose, equalling the length of the corolla, pappus of ray-flowers similar but somewhat shorter; achenes glabrous or glabrate; achenes of ray-flowers occasionally hairy toward the base with a few scattered bidentate hairs.

Distribution: western Wyoming to Oregon, southward into Utah.

Specimens examined:

YELLOWSTONE NATIONAL PARK: Mammoth Hot Springs, July 5, 1902, *Mearns* (F, No. 121847).

Wyoming: Piney Mt., 25 miles west of Big Piney, Sublette Co., Summit, July 12, 1922, *E. & L. Payson 2694* (M, R); calcareous slide rock, Teton Pass Mts., east of Victor, alt. 2831 m., July 22, 1920, *E. & L. Payson 2078* (M, R); mountains near Cottonwood Lake, east of Smoot, Lincoln Co., alt. 3200 m., Aug. 2, 1923, *Payson & Armstrong 3706* (M, R); Sheep Mt. (Ferry Peak), Snake River Range, near Alpine, Lincoln Co., July 11, 1923, *Payson & Armstrong 3474* (M, R); in vicinity of Green River Lakes, Sublette Co., alt. 3169 m., Aug. 5, 1925, *E. & L. Payson 4542* (M).

Idaho: subalpine slopes of loose calcareous soil, base to summit of mountains northeast of lake, Henry Lake, Fremont Co., alt. 2678 m., July 11, 1920, *E. & L. Payson 1986* (M, R); Mt. Chauvet, July 29, 1897, *Rydberg & Bessey 5131* (F, R).

Utah: canyon above Tropic, alt. 2154 m., May 29, 1894, *Jones* (Pomona, No. 40754); mountains above Silver Lake, July 30, 1880, *Jones* (Pomona, No. 40756); Alta, above the Flagstaff Mine, Aug. 7, 1879, *Jones* (Pomona, No. 40755, type of *T. montana*); loose stony soil, Uintah Mts., Dyer Mine, July 3, 1902, *Goodding 1238* (R, M, *co-type* of *T. dejecta*).

Oregon: subalpine ridges of Wallowa Mts., alt. 2015 m., July 31, 1899, *Cusick 2294* (F, M, *co-types* of *T. alpigena*).

9. T. Watsoni Gray, Proc. Am. Acad. **16:** 84. 1880; Syn. Fl. N. Am. **1²:** 168. 1884, and ed. 2, 168. 1886 and 1888; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 509. 1909; Tidestrom, Contr. U. S. Nat. Herb. **25:** 554. 1925.

T. strigosa Eaton, non. Nutt. Bot. King's Exp. 145. 1871; Gray, Syn. Fl. N. Am. **1²:** 168. 1884, and ed. 2, 168. 1886 and 1888.

Caulescent, hirsute with a close appressed pubescence; the caudex sending up a number of branched, sparingly leafy stems; leaves mostly obovate-spathulate, 2–4 cm. long, 0.2–0.8 cm. broad, narrowed into a petiole; heads on short bracteate or naked peduncles, 0.3–1 cm. long, 1–1.5 cm. in diameter including the rays; involucre 2-seriate; bracts oblong-lanceolate, margins membranaceous, lacerate-ciliate; ray-flowers with a reduced pappus of unequal capillary bristles shorter than the diameter of the achene;

pappus of the disk-flower equalling or surpassing the corolla; achenes pubescent with bidentate hairs.

Distribution: southeastern Oregon through Nevada to southwestern Utah.

Specimens examined:

UTAH: Dugway, May 28, 1891, *Jones* (M); Glenwood, alt. 1692 m., May 24, 1875, *Ward 92* (F, M).

NEVADA: 1891, *A. J. Jones* (M).

OREGON: sandy soil near Vale, May, 1896, *Leiberg 2067* (M); common on hills, in the region of Malheur River, June 19, 1898, *Cusick 1935* (F, M).

10. T. florifer (Hook.) Gray, Proc. Am. Acad. **16**: 84. 1880; Syn Fl. N. Am. 1^2: 167. 1884, and ed. 2, 167. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 157. 1886; Howell, Fl. Northwest Am. 306. 1897; Piper, Contr. U. S. Nat. Herb. **9**: 563. 1906; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

T. strigosa Gray in Wilkes' Exp. **17**: 344. 1874, not Nutt., fide Gray, Proc. Am. Acad. **16**: 84. 1880.

T. florifer Gray var. *communis* Jones, Proc. Calif. Acad. II. **5**: 697. 1895.

Erigeron ? florifer Hook. Fl. Bor. Am. **2**: 20. 1834.

Aplopappus florifer Hook. & Arn. Bot. Beechey Voy. 351. 1841, excl. var. β.

Stenotus florifer Torr. & Gray, Fl. N. Am. **2**: 238. 1842, excl. var. β.

Caulescent, cinereous-hirsute; the caudex sending up a number of simple or branched stems 5–18 cm. high, leafy throughout; leaves linear or the lowest lanceolate-spathulate, acute, mostly apiculate-acuminate; heads 2–3 cm. in diameter including the rays, solitary, terminating the branches; involucre 2–3-seriate; bracts linear-lanceolate and acute, of about equal length, the membranaceous margins lacerate-ciliate; ray-flowers with pappus similar to that of the disk-flowers but varying in length from about the width of the achene to nearly as long as that of the disk-flowers; pappus of disk-flower composed of coarse, white setae which exceed the corolla in length; achenes densely pubescent with bidentate hairs. Plate 5, figs. 25–28.

Distribution: dry hills and plains, central Washington and Oregon, southeastward through southern Idaho, Utah, to western Wyoming.

Specimens examined:

WYOMING: moist rich bottoms, Gros Ventres Fork, alt. 2000 m., June 10, 1860, *Hayden* (M).

IDAHO: ditch banks along fields, Challis, Custer Co., alt. 1662 m., July 15, 1916, *Macbride & Payson 3225* (M, R); clayey hills, Kings Hill, Elmore Co., alt. 800 m., July 16, 1911, *Nelson & Macbride 1129* (M, R); dry stony hillsides and dry flats, Arco, Blaine Co., alt. 1640 m., July 3, 1916, *Macbride & Payson 3095* (M, R); loose soil, Reynolds Creek, Owyhee Co., alt. 1538 m., July 3, 1911, *Macbride 1017* (M, R); gravelly slopes, New Plymouth, Canyon Co., alt. 680 m., May 21, 1910, *Macbride 90* (M, R); near Nampa, July 1, 1892, *Mulford* (M).

UTAH: Joseph City, Sevier Co., alt. 1692 m., May 13, 1899, *Jones 6379* (M); Marysvale, alt. 1846 m., May 31, 1894, *Jones 5323* (M, F); rim of Great Salt Lake Desert, May 6, 1889, *H. Engelmann* (M); sage-brush slopes, Milford, June 5, 1902, *Goodding 1046* (R).

WASHINGTON: Ritzville, Adams Co., alt. 480 m., June 6, 1893, *Sandberg & Leiberg 169* (F, M); Craigs Ferry, Kittitas Co., July 15, 1903, *Cotton 1361* (M); Columbia River opposite Umatilla, Apr. 20, 1882, *Howell* (F, No. 206944); Columbia River opposite Umatilla, Apr. 29, 1882, *Howell* (M); Wilson Creek, June, 1893, *Sandberg & Leiberg* (M); Yakima region, Cascade Mts., June, 1882, *Brandegee* (M).

OREGON: near Lexington, Morrow Co., alt. 420 m., May 7, 1894, *Leiberg 34* (F, M); near Umatilla, May 1, 1882, *Howell* (F, No. 396898); on open plains, Cline Falls, Crook Co., May 22, 1905, *Nelson 815* (M, R); dry banks of Deschutes River five miles below Bend, July 30, 1920, *Peck 9708* (M); stony hills west of Silver Creek (and common westward), June 28, 1901, *Cusick 2616* (F, M, R).

11. T. scapigera Eaton, Bot. King's Exp. 145. *t. 17.* 1871; Gray, Proc. Am. Acad. **16**: 84. 1880; Syn. Fl. N. Am. **1**^{2}: 168. 1884, and ed. 2, 168. 1886 and 1888; Rydb. Fl. Rocky Mts. 874.

1917, and ed. 2, 874. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925; Jepson, Man. Fl. Plants California, 1044. 1925.

Aplopappus florifer var. β Hook. & Arn. Bot. Beechey Voy. 351. 1841 (fide Gray).

Stenotus florifer var. β Torr. & Gray, Fl. N. Am. **2**: 238. 1842 (fide Gray).

T. scapigera var. *caulescens* Eaton, Bot. King's Exp. 145. 1841; Gray, Proc. Am. Acad. **16**: 84. 1880; Syn. Fl. N. Am. **1**²: 168. 1886, and ed. 2, 168. 1886 and 1888.

T. scapigera var. *ambigua* Gray, Proc. Am. Acad. **16**: 84. 1880; Syn. Fl. N. Am. **1**²: 168. 1884, and ed. 2, 168. 1886 and 1888; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

T. ambigua (A. Gray) Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

Herbaceous perennial, canescent with fine appressed pubescence; caudex bearing tufted leaves; leaves narrowly spathulate to obovate, 1–3 cm. long, 0.3–0.8 cm. wide, lamina sometimes emarginate, narrowed into a petiole; flowering scapes 1–5 cm. long, naked or 1–2-bracted, sometimes leafy; heads 2–2.5 cm. in diameter including the rays; involucre 2–3-seriate; bracts oblong-lanceolate, acute, margins lacerate-ciliate; pappus of ray-flower similar to that of the disk but somewhat shorter; pappus of disk-flower plurisetose, exceeding the length of the corolla; achenes pubescent with bidentate hairs.

Distribution: Wyoming to northeastern California; also in New Mexico.

Specimens examined:

Wyoming: Holm Lodge, about 40 miles west of Cody, Park County, Aug. 26 and 27, 1922, *von Schrenk* (M).

New Mexico: Santa Fe, 1847, *Fendler 351* (Phil.); without definite locality, *Kern* (in part) (Phil.).

Utah: Rabbit Valley, alt. 2092 m., Aug. 6, 1875, *Ward 523* (U. S., type of *T. scapigera* var. *ambigua*); Deep Creek, June 6, 1891, *Jones* (Pomona, No. 40882).

Nevada: Monitor Valley, alt. 1538 m., July, 1868, *Watson 519* (US, type of *T. scapigera* var. *caulescens*); eastern Nevada, 1883, *Meehan* (Phil.).

California: Buffalo Ravine near Surprise Valley, Apr. 1879, *Lemmon 29* (M).

12. T. spathulata Nutt. Trans. Am. Phil. Soc. N.S. **7:** 305. 1841; Torr. & Gray, Fl. N. Am. **2:** 186. 1842; Eaton, Am. Nat. **8:** 213. 1874; Gray, Proc. Am. Acad. **16:** 86. 1880; Syn. Fl. N. Am. **1**[2]: 169. 1884, and ed. 2, 169. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 158. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 510. 1909; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922.

T. condensata Eaton, Am. Nat. **8:** 213. 1874; Gray, Proc. Am. Acad. **16:** 83. 1880; Syn. Fl. N. Am. **1**[2]: 167. 1884, and ed. 2, 167. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 157. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 519. 1909; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

T. Parryi var. *alpina* Gray, Proc. Am. Acad. **16:** 83. 1880; Syn. Fl. N. Am. **1**[2]: 167. 1884, and ed. 2, 167. 1886 and 1888; Coulter, Manual Rocky Mt. Region, 156. 1885.

T. alpina (Gray) Rydb. Mem. N. Y. Bot. Gard. **1:** 390. 1900; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 509. 1909; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

Caespitose perennial, 3–5 cm. high; leaves crowded, rosulate, obovate to spathulate, 1–1.5 cm. long, 0.2–0.4 cm. broad, densely subsericeous-villose to villose-lanate; heads sessile or pedunculate, 1–5 cm. in diameter including the rays; involucre usually serrate; bracts pinkish, oblong-lanceolate, those of the inner series with a weak attenuate apex, the narrow margins scarious, lacerate-ciliate; pappus of ray- and disk-flowers similar, composed of slender setae, as long as the corolla of the disk-flower; achenes pubescent with bidentate hairs.

Distribution: alpine and subalpine regions of southwestern Alberta and western Wyoming.

Specimens examined:

Yellowstone National Park: Electric Peak, alt. 2770 m., July 26, 1902, *E. C. Smith* (F).

Wyoming: high alpine ridge between the valleys of the Stinking Water and the Yellowstone, 1873, *Parry 142* (F, M); northwestern Wyoming, 1873, *Parry 145* (F, G, M, type of *T. Parryi* var. *alpina*); high alpine peak, Owl Creek Range, July, 1874, *J. D. Putnam* (G, type of *T. condensata*); "Black Hills of Platte," *Nuttall* (Phil.); shale flats, Bush Ranch, June 10, 1910, *Nelson 7054* (R).

CANADA: High River, Rocky Mts., alt. 2308 m., July, 1884, *Dawson* (G).

Note: Dr. C. C. Parry says in a note accompanying the type of *T. condensata* Gray: "Single specimen from a high alpine peak, Owl Creek Range, by J. D. Putnam. I take this to be a condensed alpine form of 145." The head of Putnam's specimen is larger than in No. 145 and looks very much as if it were a fasciation of several heads. Otherwise, these specimens are identical. In the specimens cited the heads vary from 1 to 5 cm. in diameter. The presence of intermediates indicates that the size of the head cannot be used as a means of specific demarcation.

13. **T. mexicana** Gray, Mem. Am. Acad. N.S. (Pl. Fendl.) **4:** 70. 1849; Walp. Ann. Syst. Bot. **2:** 822. 1851–1852; Gray, Proc. Am. Acad. **16:** 86. 1880; Syn. Fl. N. Am. **1**^{2}**:** 169. 1884, and ed. 2, 169. 1886 and 1888; Hemsley, Biol. Cent.-Am. Bot. **2:** 118. 1881.

Caulescent; conspicuously cinereous with strigose pubescence; stems decumbent, simple or branched, 5–17 cm. long, leafy throughout; leaves linear, sometimes linear-spathulate, 1–2.5 cm. long, 0.1–0.2 cm. broad; heads usually solitary on terminal peduncles, 1–2 cm. in diameter including the rays; involucre distinctly 2-seriate; bracts of equal length and all very obtuse, membranous-margined; ray-flowers fertile with a much-reduced pappus; pappus of the disk-flowers equalling the corolla in length; achenes sparsely pubescent with glochidiate-tipped hairs.

Distribution: east central Mexico, southern Coahuila, Zacatecas to Hidalgo.

Specimens examined:

MEXICO:

COAHUILA: Saltillo, March 22, 1877, *Gregg 327* (M, TYPE); Saltillo, alt. 1650 m., June 5, 1909, *Arsène 3387* (M); Saltillo, Apr. 1–15, 1880, *Ed. Palmer 499* (F).

ZACATECAS; near Conception Del Oro, Aug. 11–14, 1904, *Ed. Palmer 252* (M); vicinity of Cedros, Aug., 1908, *Kirkwood 110* (F); low places, plains, Cedros, Aug., *Lloyd 110* (M).

HIDALGO: rocky flats and mountains, Ixmiquilpan, July, 1905, *Purpus 1345* (M, F); calcareous bluffs near Tula, alt. 2080 m.,

Aug. 6, 1896, *Pringle 6573* (M); dry calcareous rocks near Tula, alt. 2080 m., Sept. 16, 1902, *Pringle 9967* (M, F); calcareous plains near Pachuca, alt. 2350 m., Aug. 2, 1898, *Pringle 7580* (F, R).

14. T. strigosa Nutt. Trans. Am. Phil. Soc. N.S. **7**: 306. 1841; Torr. & Gray, Fl. N. Am. **2**: 186. 1842; Gray, Mem. Am. Acad. N.S. (Pl. Fendl.) **4**: 70. 1849, in part; Syn. Fl. N. Am. **1**^{2}: 169. 1884, and ed. 2, 169. 1886 and 1888; Proc. Am. Acad. **16**: 86. 1880; Coulter, Man. Rocky Mt. Region, 158. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 509. 1909; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

T. Fendleri Gray, Mem. Am. Acad. N.S. (Pl. Fendl.) **4**: 70. 1849; Walp. Ann. Syst. Bot. **2**: 822. 1851–1852; Gray, Syn. Fl. N. Am. **1**^{2}: 169. 1884, and ed. 2, 169. 1886 and 1888; Proc. Am. Acad. **16**: 86. 1880; Coulter, Man. Rocky Mt. Region, 158. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 509. 1909; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Rydb. Fl. Rocky Mts. 874. 1917, and ed. 2, 874. 1922.

Caulescent; cinereous with close strigulose pubescence, the caudex sending up a number of simple or branched stems, 3–25 cm. high, nearly naked below, leafy towards the inflorescence; leaves linear to linear-spathulate, 1–3 cm. long, 0.3–0.6 cm. broad, gradually narrowed into a slender petiole; heads subsessile and solitary or terminating the lateral branches in 1–3-headed clusters; heads about 1.5 cm. in diameter including the rays; involucre 2–4-seriate; bracts oblong-lanceolate, membranaceous-margined and lacerate-ciliate; ray-flowers about 15, rays pink or rose-purple, with a much-reduced pappus; pappus of disk-flowers plurisetose, as long as the corolla; achenes pubescent with glochidiate-tipped hairs. Plate 4.

Distribution: dry sandy soil, southwestern Wyoming to New Mexico and Arizona and adjacent Mexico.

Specimens examined:

Wyoming: dry flats 21 miles west of Green River, June 19, 1923, *Payson & Armstrong 3205* (M, R); Church Buttes, Fort Bridger, July, 1873, *Porter* (M, Phil.); without definite locality, *Parry* (Phil); Green River, May 30, 1897, *Nelson 3031* (M, R).

COLORADO: "R. Mts. Platte," *Nuttall* (Phil., TYPE); Salida, June 19, 1898, *Baker, Earle & Tracy 1016* (M); Texas Cr., Fremont Co., 1874, *Brandegee 951* (M); Arkansas River near Puncha Pass, Sept. 24, 1878, *Jones 767* (M); Huerfano, Aug., 1867, *Parry 98* (M, R); dry slopes, alt. 1662 m., Paradox, Montrose Co., June 17, 1912, *Walker 93* (M); adobe plains of San Juan Valley, July, 1875, *Brandegee* (M); southern Colorado, *Brandegee* (Phil.); sands of Huerfano Cr., Sept., 1875, *Brandegee* (M); McElmo Cr., June 3, 1892, *Eastwood* (F, No. 82217); alkaline hillsides, Naturita, 1662 m., May 19, 1924, *Payson 321* (F, M, R); Arkansas Valley, Sept., 1873, *Wolf 517* (F).

NEW MEXICO: near Espanola, Santa Fe Co., alt. 1723 m., May 17, 1897, *Heller & Heller 3547* (M); Mangas Springs, 18 miles northwest of Silver City, Grant Co., alt. 1323 m., Apr. 12, 1903, *Metcalfe 15* (M, R); Mesilla Valley, Dona Ana Co., alt. 1184 m., Apr. 19, 1907, *Wooton & Standley 3237* (M); sand hills near Mesilla, May 4, 1906, *Standley* (M); gravelly hillsides, Santa Fe, May–July, 1847, *Fendler 350* (M, *co-type* of *T. Fendleri*); El Paso, Apr., 1852, *Parry* (M); Santa Fe, 1891, *Alcott* (M, No. 890501); sandy banks of the Rio Grande and stony hills, El Paso, March–June, 1851–2, *Wright 1172* (Phil., M); without definite locality, *Kern* (Phil.); gravelly hills, Santa Fe, May, 1847, *Fendler 351* (Phil., M); Aztec, May 4, 1899, *Baker 728* (F, M, R); loamy flats, Hillsboro (N. Percha), Sierra Co., alt. 1692 m., Oct. 28, 1904, *Metcalfe 1510* (F, M); Mesilla Valley, Dona Ana Co., alt. 1154 m., Apr. 2, 1907, *Wooton & Standley* (F, M).

ARIZONA: dry spots in river bottoms, Rio Verde, Fort Whipple, Sept. 6, 1865, *Coues & Palmer 523* (M); sandy soil, Beaver Cr., Sept., 1903, *Purpus 8300* (M); *Smart 92* (F); *Voth 7* (F).

15. T. incana Nutt. Trans. Am. Phil. Soc. N.S. **7**: 305. 1841; Torr. & Gray, Fl. N. Am. **2**: 155. 1842; Walp. Rep. **2**: 575. 1843; Gray, Syn. Fl. N. Am. **1**²: 169. 1884, and ed. 2, 169. 1886 and 1888; Proc. Am. Acad. **16**: 86. 1880; Coulter, Man. Rocky Mt. Region, 157. 1885; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 509. 1909; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

T. Fremontii Torr. & Gray, Boston Jour. Nat. Hist. **5:** 106. 1845.

T. incana var. *ambigua* Jones, Zoe **4:** 264. 1893.

T. incana var. *prolixa* Jones, Contr. Western Bot. 13: 15. 1910.

Herbaceous perennial, strigulose-cinereous, caespitose; stem usually 3–6 cm. high; leaves spathulate, sometimes apiculate, petiolate, 2–4 cm. long and 0.2–0.5 cm. broad, the uppermost clustered at the base of the heads and seldom surpassing them in length; heads 1–2.5 cm. in diameter including the rays, usually sessile; involucre 2–3-seriate; bracts broadly lanceolate, their scarious margins lacerate-ciliate; pappus of the disk-flower plurisetose, equalling the length of the corolla; pappus of the ray-flower similar to that of the disk-flower but only one-third to one-half as long; achenes pubescent with glochidiate-tipped hairs.

Distribution: Wyoming, south through western Colorado into northwestern New Mexico, west into eastern Arizona and Utah.

Specimens examined:

Wyoming: "Black Hills of the Platte," *Nuttall* (Phil., type); on a stony flat, Granger, Uinta Co., June 14, 1899, *A. & E. Nelson 5403* (M, R); Granger, June 10, 1898, *A. Nelson 4622* (M, R); deep hot sands, Alcova, Natrona Co., July 1, 1901, *Goodding 166* (M, R).

Colorado: dry rocky south slope, Norwood Hill, San Miguel Co., alt. 2154 m., Aug. 11, 1912, *Walker 448* (M, R); Grand Junction, May, 1891, *Eastwood* (F, Pomona); Grand Junction, June, 1892, *Eastwood* (F, Pomona); Grand Junction, Apr. 15, 1891, *Jones* (Pomona, No. 39662); Grand Junction, alt. 1412 m., June 11, 1901, *Baker 105* (M).

New Mexico: Aztec, May 6, 1899, *Baker 729* (M, R).

Utah: stony slopes, Thompson Springs, alt. 1630 m., May–Oct., 1899, *Purpus 6765* (M); Thompson Springs, May 7, 1891, *Jones* (Pomona, No. 39664, type of *T. incana* var. *ambigua*); Richfield, alt. 1692 m., June 5, 1875, *Ward 176* (F, M); Lower Crossing, alt. 1384 m., July 2, 1898, *Jones* (M, No. 121121); Westwater, May 6, 1891, *Jones* (Pomona, No. 39663); Westwater, alt. 1380 m., June 28, 1898, *Jones* (Pomona, No. 39629);

Chepeta Well, alt. 1540 m., May 23, 1908, *Jones* (Pomona, No. 39630, TYPE of *T. incana* var. *prolixa*).

ARIZONA: near Oraibi, 1900, *Voth 19* (F); Hackberry, May 26, 1884, *Jones 4516* (F, R).

16. T. arizonica Gray, Proc. Am. Acad. **16**: 85. 1880; Syn. Fl. N. Am. 1²: 169. 1884, and ed. 2, 169. 1886 and 1888; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

T. arizonica × *incana* Jones, Zoe **2**: 248. 1891.

Depressed subacaulescent and multicipital, branching from a perennial root, forming a loose pulvinate tuft 3–4 cm. high, minutely sericeous-canescent; leaves short, obovate-spathulate, 2–3 cm. long, 0.2–0.5 cm. broad, seldom surpassing the foliose-fulcrate heads; heads 1–1.5 cm. in diameter including the rays; involucre 2–3-seriate; bracts lanceolate, obtuse, with narrow, membranaceous lacerate-ciliate margins; pappus of the disk-flower plurisetose, equalling the length of the corolla, that of the ray-flower similar but shorter.

Distribution: southwestern Colorado and Arizona; doubtless also in Utah.

Specimens examined:

COLORADO: Naturita, June 1, 1917, *Payson 989* (M, R); rocky hillside, Naturita, alt. 1670 m., Apr. 21, 1914, *Payson 242* (F, M, R); dry arroyo sides, Paradox, Montrose Co., alt. 1666 m., June 17, 1912, *Walker 90* (M, R); Paradox, Montrose Co., alt. 1354 m., *Walker 206* (R); Grand Junction, Mesa Co., May 31, 1921, *Osterhout 6116* (R).

ARIZONA: Buckskin Mts., June 19, 1890, *Jones* (Pomona, No. 39642, TYPE of *T. arizonica* × *incana*); Milford, alt. 1540 m., June 19, 1880, *Jones 1794* (F, M); Ash Fork, May 13, 1883, *Rusby 660* (M); "southern Utah, northern Arizona, &," *Palmer 204* (M).

17. T. leptotes (Gray) Osterh. Muhlenbergia **4**: 69. 1908; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922.

T. sericea var. *leptotes* Gray, Proc. Am. Acad. **16**: 85. 1880;

Coulter, Man. Rocky Mt. Region, 157. 1885; Gray, Syn. Fl. N. Am. 1^2: 169. 1884, and ed. 2, 1886 and 1888.

T. lepotes Osterh. Muhlenbergia **4**: 69. 1908 (doubtless a typographical error, since the bibliographical citation in synonymy refers to var. *leptotes* Gray).

Acaulescent; leaves pubescent with hirsute appressed hairs, narrowly linear, attenuate at the base, 2–4 cm. long, 0.1–0.2 cm. broad, surpassing the shortly pedunculate or sessile heads; heads about 1.5 cm. in diameter including the rays; involucre 3–4-seriate; bracts broadly linear, their membranaceous margin scarcely wider than the lacerate ciliation; pappus of ray- and disk-flowers similar, plurisetose, setae equalling the length of the corolla of the disk-flower, rarely shorter; achenes only sparsely pubescent with glochidiate-tipped hairs.

Distribution: known only from the Middle Park region of Colorado.

Specimens examined:

COLORADO: Middle Park, coll. of 1864, *Parry* (G, TYPE; M, *co-type*, No. 121020); "Estes Park," coll. of 1864, *Parry* (F, No. 209717); Kremmling, Grand Co., June 22, 1907, *Osterhout 3487* (R); Kremmling, Grand Co., May 26, 1915, *Osterhout 5221* (R).

18. T. exscapa (Richards.) Porter, Mem. Torr. Bot. Club **5**: 321. 1894, in part, as to name-carrying synonym; Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 509. 1909, in part, excluding synonym *T. sericea;* Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 692. 1915; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922, as to name only; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925, in part, excluding *T. sericea* and *T. mensana.*

Aster ? exscapus Richards. Frankl. Jour. Bot. App. 7, p. 748. 1823.

T. sericea Hook. Fl. Bor. Am. **2**: 16. 1834, in part, as to synonym, *Aster exscapus,* and plant of Richardson; DC. Prodr. **7**: 273. 1838, in part; Walp. Rep. **2**: 575 and 957. 1843, in part, as to *Aster exscapus;* Torr. & Gray, Fl. N. Am. **1**: 185, 1842, in part, as to *Aster exscapus* and plant of Richardson; Gray, Proc.

Am. Acad. **16**: 85, 1880, in part, as to *Aster exscapus;* Syn. Fl. N. Am. 1^2: 168. 1884, and ed. 2, 168. 1886 and 1888, in part, as to *Aster exscapus.*

T. Wilcoxiana Wood, Bull. Torr. Bot. Club **6**: 163. 1875; Gray, Proc. Am. Acad. **16**: 84. 1880; Syn. Fl. N. Am., ed. 2, 1^2: 168. 1886 and 1888; Coulter, Man. Rocky Mt. Region, 157. 1885; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922.

T. sericea β *papposa* Gray, Mem. Am. Acad. N. S. (Pl. Fendl.) **4**: 70. 1849; Proc. Am. Acad. **16**: 84. 1880; Syn. Fl. N. Am. 1^2: 168. 1884, and ed. 2, 168. 1886 and 1888.

T. exscapa Wilcoxiana (Wood) A. Nels. in Coulter & Nelson, Man. Cent. Rocky Mts. 510. 1909.

T. intermedia Rydb. in Britton's Manual Fl. N. States and Canada, 944. 1901, and ed. 2, 944. 1905; Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 1922; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925.

Depressed, acaulescent, rising from a woody root-stalk; leaves linear-spathulate, 2–5 cm. long and 0.2–0.5 cm. broad, somewhat apiculate, sparsely pubescent with fine appressed hairs, somewhat glabrate; heads large, 2–3 cm. high and 3–5 cm. in diameter including the rays; involucre 4–6-seriate; bracts linear-lanceolate, obtuse, pink-tipped with membranaceous lacerate-ciliate margins; pappus of ray- and disk-flowers similar, plurisetose of elongated setae exceeding the length of the corolla of the disk-flower; achenes pubescent with glochidiate-tipped hairs.

Plate 7, figs. 29–31.

Distribution: plains from southern Alberta and Saskatchewan, south to Texas and west to Arizona; also in southern Colorado.

Specimens examined:

South Dakota: clay-hills, near Hot Springs, May 10, 1924, *McIntosh 21* (R); hills near Hot Springs, June 2, 1924, *McIntosh 166* (R).

Kansas: Trego Co., *Rich 718* (R, M, iso-type of *T. intermedia*); Clark Co., *Curtis* (M, No. 121174); arid sterile slopes near Cullison, March 31, 1888, *Norris* (M, No. 121175); gravelly hills collected within a radius of five miles of Osborne City, April 16, 1894, *Shear 2* (M).

Oklahoma: vicinity of Camp Supply, Woodward, Apr. 5, 1925, *Wilcox* (F, M); hillside, Alva, Apr. 17, 1913, *Stevens 216* (M).

Texas: infrequent, rocky slopes, alpine, March 22, 1919, *Hanson* (M); rare on high mountains, Limpia, March, 1914, *Allen 36* (M); calcareous bluffs, Falls Creek, Hood Co., Apr, 1884, *Reverchon 1533* (F, M).

Colorado: near foothills, Fort Collins, Apr. 19, 1898, *Crandall 3132* (F, R); plains, Colorado Springs, May 4, 1878, *Jones 25* (F); Cheyenne Canyon, May 4, 1891, *Smith* (M, No. 121177); Canyon City, Apr. 1875, *Brandegee* (M); Rocky Mountain Fl., 39–41° lat., 1862, *Hall & Harbour 290* (F, No. 456674; M, No. 121176); Los Pinos, May, 1899, *Baker 730* (F, M, R); vicinity of New Winsor, May 11, 1899, *Osterhout* (R, F, No. 118369); Evans, 1909, *Johnston 253 A* (M); dry hillside, Naturita, *Payson 326* (M, R).

New Mexico: Raton Mts., Colfax Co., March 23, 1848, *Gordon 42* (M); sloping hillsides on grassy plains, Santa Fe, Apr.-May, 1847, *Fendler 349* (M, *co-type* of *T. sericea* β *papposa*); near Silver City, March 29, 1889, *Greene* (F).

Arizona: Flagstaff, May–Oct., 1902, *Purpus 4* (M); vicinity of Flagstaff, alt. 2154 m., June 2, 1898, *MacDougal 31* (F, R); Prescott, 1876, *Palmer* (F, No. 208510); Bright Angel, May 18–27, 1903, *Griffiths 4361* (M); Fort Whipple, May, 1865, *Coues & Palmer 365* (M); Fort Whipple, Apr. 20, 1865, *Coues & Palmer 315* (M).

Canada: at Carlton House, *Richardson* (Kew, type); sand hills, Aweme, Manitoba, May 28, 1900, *Criddle* (M); quite rare at Briggs Creek, Elbow River, Alberta, June 26, 1897, *Macoun* (C); dry slope, Medicine Hat. Alberta, May 9, 1894, *Spreadborough* (C); sandy hills, Aweme, Alberta, May 20, 1905, *Criddle 900* (M).

19. T. sericea Hook. Fl. Bor. Am. **2**: 16, *pl. 119*. 1834, in part, excluding synonym; DC. Prodr. **7**: 273. 1838, in part; Nutt. Trans. Am. Phil. Soc. N. S. **7**: 304. 1841; Walp. Rep. **2**: 575 and 957. 1843, in part, excluding *Aster exscapus;* Torr. & Gray, Fl. N. Am. **2**: 185. 1842, excluding *Aster exscapus* and the plant of Richardson; Gray, Proc. Am. Acad. **16**: 85. 1880, in part; Syn. Fl. N. Am. **1**^{2}: 168. 1884, and ed. 2, 168. 1886 and 1888, in part, as to plant from "Rocky Mountains in lat. 54°."

T. mensana Jones, Contr. Western Bot. 13, p. 15. 1910.

T. exscapa Porter in Mem. Torr. Bot. Club **5**: 321. 1894, in part, as to synonym *T. sericea;* Nelson in Coulter & Nelson, Man Cent. Rocky Mts. 509. 1909, in part, as to synonym *T. sericea;* Rydb. Fl. Rocky Mts. 875. 1917, and ed. 2, 875. 1922, in part, as to synonyms; Tidestrom, Contr. U. S. Nat. Herb. **25**: 554. 1925, in part, as to *T. sericea* and *T. mensana.*

Depressed, acaulescent, rising from a woody perennial caudex; leaves linear-lanceolate to subterete, 1–4 cm. long, 0.2–0.3 cm. wide, clustered at the base of the sessile heads, canescent with dense closely appressed sericeous pubescence, the older leaves conspicuously exceeding the head; heads 1–1.5 cm. in diameter including the rays; involucre 4–5-seriate; bracts pinkish, linear-lanceolate, acute with narrow membranaceous lacerate-ciliate margins; pappus of the disk-flower plurisetose, equalling the length of the corolla; pappus of the ray-flower variable from reduced squamellae little longer than the breadth of achene to a condition similar to that in the disk-flower; achenes pubescent with glochidiate-tipped hairs. Plate 6; pl. 7, fig. 32–34.

Distribution: Rocky Mountains, Alberta to Colorado and Utah; also in the Black Hills of South Dakota.

Specimens examined:

South Dakota: dry hillside near Pringle, alt. 1508 m., Apr. 19, 1909, *Murdoch 3510* (F).

Montana: Helena, 1892, *Newton* (F); Gallatin Co., June, 1888, *Tweedy 20* (F); Custer, Apr. 12, 1890, *Blankinship 147* (M); chiefly on the plains, Helena, May 18, 1887, *Anderson* (M, No. 121170).

Wyoming: Laramie, May 8, 1897, *A. Nelson 2862* (F); Laramie Hills, Apr. 28, 1896, *A. Nelson 1883* (F); Laramie plains, Apr. 12, 1894, *A. Nelson 7* (F, M); Laramie, Albany Co., May, 1899, *A. Nelson 7055* (M, R); March 8, 1860, *Hayden* (M, No. 121166); March 25, 1860, *Hayden* (M, No. 121161); Deer Creek, west of Fort Laramie, Apr. 15, 1860, *Hayden* (M, No. 121160); head of Muddy Creek, May 4, 1860, *Hayden* (M, No. 121167); Shoshone Mts., May, 1907, *Hapeman* (M, No. 867626).

Colorado: near Boulder, Apr. 1901, *Ramaley 654* (R); Rocky Mts., 39–41° lat., 1862, *Hall & Harbour 290* (F, Nos. 314634 and 17721); Larimer Co., March 30, 1896, *Baker 1250* (F, M); West

Cliff, Custer Co., Apr. 1888, *Cockerell* (F, No. 352961); steep slope of "The Mesa," alt. 2738 m., Apr. 23, 1911, *Murdoch 4503* (F, M); Georgetown, June, 1873, *Wolf 416* (F); Middle Park, 1861, *Parry 35* (F); Denver, May, 1894, *Bethel* (F, No. 91820); dry hills, Mt. Vernon, canyon, Jefferson Co., alt. 1730 m., Apr. 13, 1920, *Clokey 4338* (F, R); foothills west of Fort Collins, alt. 1692 m., March 3, 1896, *Baker* (M, No. 121168); Gregory Canyon, Boulder, Boulder Co., May 21, 1912, *Vestal 368* (M); infrequent, upper mesas near Boulder, alt. 1477 m., March 19, 1921, *Hanson c160* (M); South Park, Aug., 1873, *Rothrock* (F, No. 304922 in part).

Utah: Theodore, Benches of the Uintas, alt. 2308 m., May 14, 1908, *Jones* (Pomona, No. 40603, type of *T. mensana*).

Canada: Rocky Mountains, *Drummond* (Kew, type; also C, No. 7710); clay banks, Medicine Hat, Apr. 22, 1894, *Spreadborough & Macoun* (C, M); hillsides, Sweet Grass Hills, July 15, 1895, *Macoun* (C); Fort McLeod, Alberta, coll. of 1888, *Cowdry* (C).

Species Excluded

Townsendia Wrightii Gray, Bot. Mex. Bound. Surv. p. 78. 1859 = Aster Wrightii Gray, Pl. Wright. Part II, p. 75. 1853.

List of Exsiccatae

The distribution numbers are printed in *italics*. The number in parenthesis is the species number used in this revision.

Aiton, G. B. (1).
Alcott, W. P. (3); (14).
Allen, Miss E. A. *36* (18).
Anderson, F. W. (1); (19).
Arsène, Bro. G. *3387* (13).
Baker, C. F. (4); *727* (6); *728* (14); *105*, *729* (15); *730* (18); *1250* (19).
Baker, C. F., Earle, F. S., and Tracy, S. M. *548* (6); *1016* (14).
Bethel, E. (19).
Bethel, E., Willey, F. S., and Clokey, I. W. *4340* (6).
Blankinship, J. W. *301*, *301a* (1); *147* (19).
Brandegee, T. S. (3); *487* (4); (10); *951* (14); (18).
Brumback, Miss F. M., and Davis, Miss C. A. *178* (4).
Burglehaus, F. H. (1).
Carleton, M. H. (4).
Clokey, I. W. *2810* (4); *4338* (19).
Cockerell, T. D. A. (19).
Cotton, J. S. *1361* (10).
Coues, E., and Palmer, E. *523* (14); *315*, *365* (18).
Cowdry (19).
Crandall, C. S. (4); *3132* (18).
Criddle, M. *900* (18).
Curtis, C. (18).
Cusick, W. C. *2295* (1); *2294* (8); *1935* (9); *2616* (10).
Dawson, G. M. (12).

Doty, T. *59* (1).
Drummond, Thomas (19).
Eastwood, Miss A. (14); (15)
Eggert, H. (5).
Eikenberry, W. L. *59* (1).
Ellis, Miss C. C. *56* (3).
Engelmann, G. (3).
Engelmann, H. (4); (10).
Fendler, A. *353* (3); *157*, *533* (4); *351* (11); *350*, *351* (14); *349* (18).
Flodman, J. H. *828* (1).
Goodding, L. N. *1238* (8); *166* (15); *1235*, *561* (2); *1046* (10).
Gordon, A. L. *42* (18).
Greene, E. L. (4); (18).
Gregg, J. *327* (13).
Griffiths, D. *4361* (18); *5340* (2).
Hall, E. (4).
Hall, E., and Harbour, J. P. *289* (4); *290* (18); *290* (19).
Hanson, H. C. *c159* (4); (18); *c160* (19).
Hapeman, H. (19).
Hayden, F. V. (1); (4); (19); (10).
Heller, A. A., & E. G. *3726* (3); *3547* (14).
Howell, T. J. (10).
Johnston, E. L. *253*, *414b*, *492* (4); *253a* (18).
Jones, A. J. (9).
Jones, M. E. *4157* (3); *284* (4); (8); (9); *5323*, *6379* (10); (11); *767* (14); *4516* (15); *1794* (16); *25* (18); (19).
Kelsey, F. D. (1).
Kern, R. H. (11); (14).
Kirkwood, J. E. *110* (13).
Leiberg, J. B. *2067* (9); *34* (10).
Lemmon, J. G. *29* (11).
Letterman, G. W. *83* (4).
Lloyd, C. G. *110* (13).
Macbride, J. F. *90*, *1017* (10).
Macbride, J. F., and Payson, E. B. *3095*, *3225* (10).
MacDougal, D. T. *31* (18).
Macoun, J. (1); (18); (19).
McIntosh, A. C. *21*, *166* (18).
Marshall, W. F. *3138* (4).
Mearns, E. A. (1); (8).
Meehan, T. (11).
Mell and Knopf (18).
Metcalfe, O. B. *413*, *1434* (2); *15*, *1510* (14).
Moore, Mrs. C. H. (1).
Mulford, Miss I. (10).
Murdoch, J. *3510*, *4503* (19).
Nelson, A. *385*, *7373*, *8312* (4); *815* (10); *4622* (15); *7*, *1883*, *2862*, *7055* (19); *7054* (12); *3031* (14).
Nelson, A., and E. *5425* (1); *5403* (15).
Nelson, A., and Macbride, J. F. *1129* (10).
Nelson, E. *815* (10).
Newton, G. W. (19).
Norris, H. W. (18).
Nuttall, T. (12); (14); (15).
Osterhout, G. E. *6116* (16); *5221*, *3487* (17); (18).
Palmer, E. J. *14170*, *14586* (5).
Palmer, Ed. *252*, *499*, (13); *204* (16); (18).
Parry, C. C. *144* (1); (4); *142*, *145* (12); *93*, *94*, (14); (17); *35* (19).
Patterson, H. N. *49* (4).
Payson, E. B. *1160* (6); *321* (14); *989*, *242* (16); *326* (18).
Payson, E. B., and L. B. *1979*, *2026*, *2632*, *2762*, *4642*, *3693* (1); *4542*, *1986*, *2078*, *2694*, *4542* (8).
Payson, E. B., and Armstrong, G. M. *3693* (1); *3474*, *3706* (8); *3205* (14).
Peck, M. E. *9708* (10).
Porter, T. C. (4); (14).
Pringle, C. G. *6573*, *7580*, *9967* (13).
Purpus, C. A. *532* (7); *1345* (13); *8300* (14); *6765* (15); *4* (18).
Putnam, J. D. (12).
Ramaley, F. *654* (19).
Redfield, J. H. *478* (4).
Reverchon, J. *3320* (5); *1533* (18).
Rich, J. A. *718* (18).
Richardson, John (18).
Rothrock, J. T. *875* (7); (19).
Robbins, W. W. *8189* (3).
Rusby, H. H. *660* (16).
Rydberg, P. A., and Bessey, E. A. *5132* (1); *5131* (8).
Sandberg, J. H., and Leiberg, J. B. *169* (10).
Schmoll, Hazel M. *1348*, *1212* (6).
Shear, C. L. *2* (18).
Smart, D. *92* (14).
Smith. B. H. (6).

Smith, E. C. *16* (1); (12); (18).
Spreadborough, W. (18).
Spreadborough, W., and Macoun, J. (19).
Standley, P. C. *4412*, *4621* (3); (14).
Starz, E. (1).
Stevens, G. W. *216* (18).
Tweedy, F. *228*, *695* (1); *20* (19).
Umbach, L. M. *142*, *254* (1).
Vasey, G. R. (3); *304* (4).
Vestal, A. A. *368* (19).
Visher, S. S. *2138* (4).
Von Schrenk, H. (11).
Voth, H. R. *7* (14); *19* (15).
Vreeland, F. K. *639* (3).
Walker, E. P. *93* (14); *448* (15); *90*, *206* (16).
Walker, Mrs. S. B. (4).
Ward, L. F. *92* (9); *523* (11); *176* (15).
Watson, S. *519* (11).
Webber, H. J. (4).
Wilcox, T. E. (18).
Williams, T. A. (4).
Wolf, J. *517* (14); *416* (19).
Wooton, E. O. (2).
Wooton, E. O. and Standley, P. C. *3237* (14).
Wright, C. *1172* (14).
Young, M. S. (5).
Young, R. T. (4).

Index to Species

New species and combinations are printed in **bold face** type; synonyms in *italics;* and previously published names in ordinary type.

Explanation of Plate

PLATE 2

Townsendia formosa Greene

New Mexico

From a co-type, *Metcalfe No. 1434*, in the Missouri Botanical Garden Herbarium.

LARSEN—REVISION OF THE GENUS TOWNSENDIA

Explanation of Plate

PLATE 3

Townsendia texensis Larsen

Northwestern Texas

From the type specimen, *Eggert*, in the Missouri Botanical Garden Herbarium No. 121021.

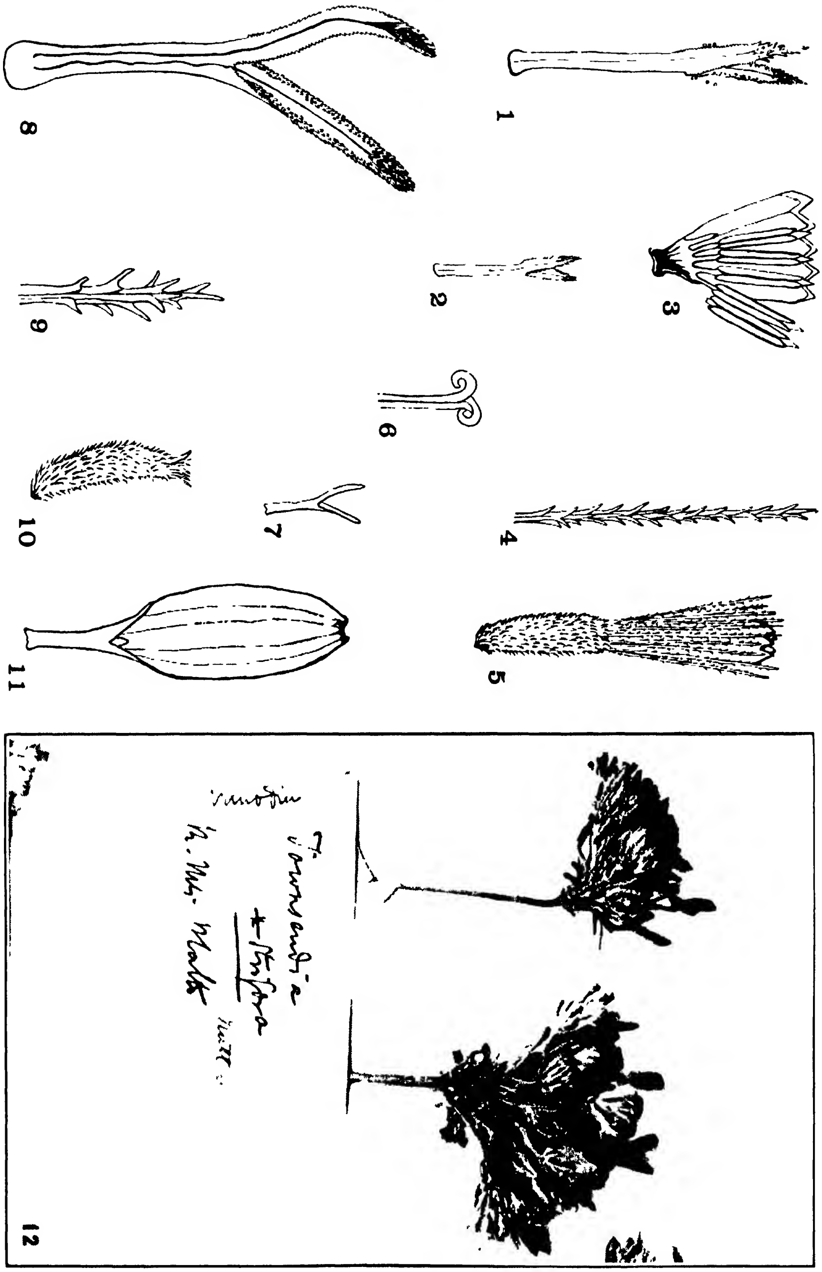
LARSEN—REVISION OF THE GENUS TOWNSENDIA

Explanation of Plate

PLATE 4

Townsendia strigosa Nuttall

Fig. 1. Style-branches of the disk-flower, greatly enlarged.
Fig. 2. Style-branches of the disk-flower, × 5.
Fig. 3. Corolla of the disk-flower showing the stamens, × 5.
Fig. 4. A seta of the disk-flower, greatly enlarged.
Fig. 5. Disk-flower, × 5.
Fig. 6. Glochidiate-tipped hair, greatly enlarged.
Fig. 7. Style-branches of the ray-flower, × 5.
Fig. 8. Style-branches of the ray-flower, greatly enlarged.
Fig. 9. A seta of the ray-flower, greatly enlarged.
Fig. 10. Achene of the ray-flower with pappus attached, × 5.
Fig. 11. Corolla of the ray-flower, × 5.
Fig. 12. Photograph of the type specimen in the Herbarium of the Academy of Natural Sciences, Philadelphia.



LARSEN—REVISION OF THE GENUS TOWNSENDIA

Explanation of Plate

PLATE 5

T. eximia Gray.

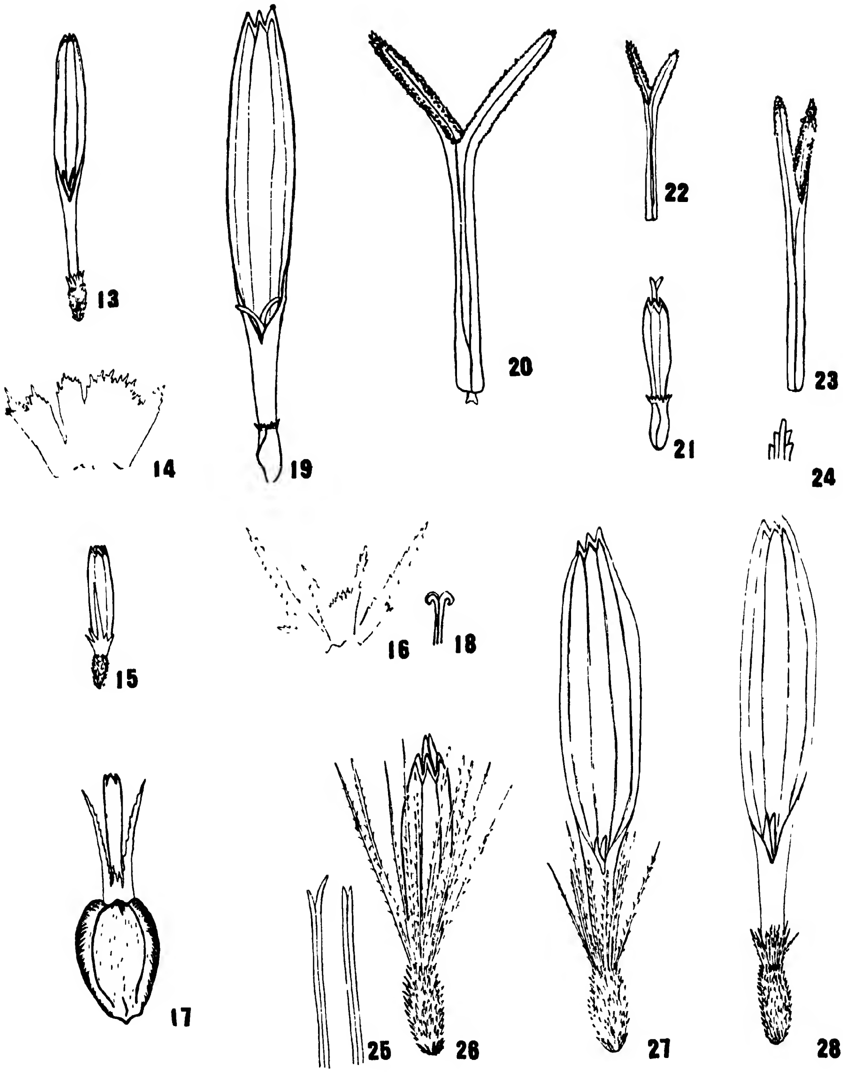
Fig. 13. Ray-flower, × 2½.
Fig. 14. Pappus of the ray-flower, greatly enlarged.
Fig. 15. Disk-flower, showing a single elongated seta in the pappus, × 2½.
Fig. 16. Pappus of the disk-flower, greatly enlarged.
Fig. 17. Achene of the disk-flower with the corolla and pappus attached.
Fig. 18. Glochidiate-tipped hair.

T. formosa Greene.

Fig. 19. Ray-flower, × 2½.
Fig. 20. Style-branches of the ray-flower, greatly enlarged.
Fig. 21. Disk-flower, × 2½.
Fig. 22. Style-branches of the disk-flower, × 5.
Fig. 23. Style-branches of the disk-flower, greatly enlarged.
Fig. 24. A seta of the pappus, greatly enlarged.

T. florifer Gray.

Fig. 25. Bidentate hairs, greatly enlarged.
Fig. 26. Disk-flower, × 5.
Figs. 27 and 28. Ray-flowers from the same head showing the variability of the pappus, × 5.



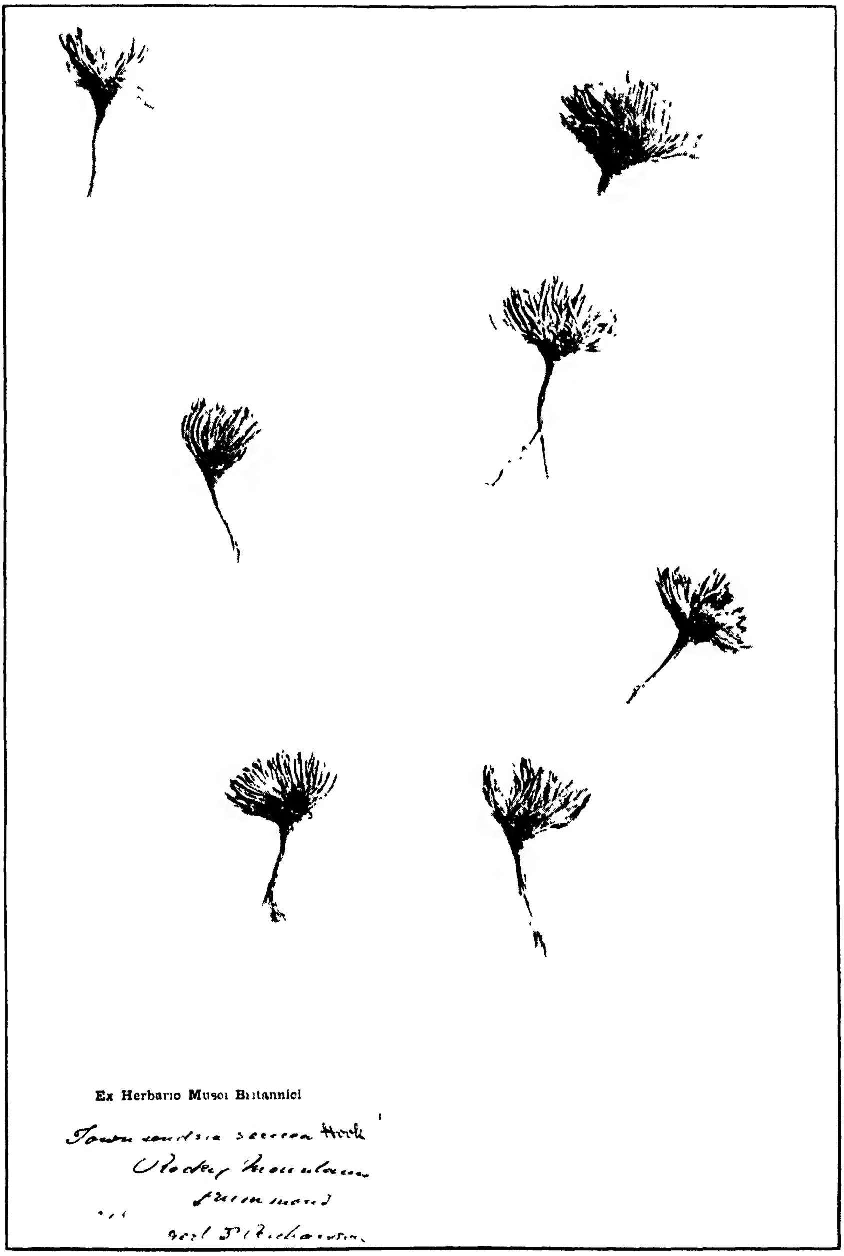
LARSEN—REVISION OF THE GENUS TOWNSENDIA

Explanation of Plate

PLATE 6

Townsendia sericea Hook.

From a co-type, *Drummond*, in the National Herbarium of the Victoria Memorial Museum, Ottawa, Canada, No. 7710.



LARSEN—REVISION OF THE GENUS TOWNSENDIA

Explanation of Plate

PLATE 7

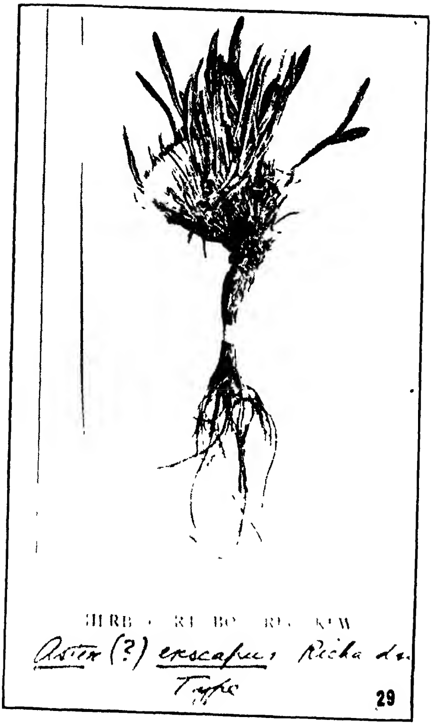
Townsendia exscapa (Richards.) Porter.

Fig. 29. Photograph of type specimen in Kew Herbarium.
Fig. 30. Ray-flower, × 5.
Fig. 31. Disk-flower, × 5.

Townsendia sericea Hook.

Fig. 32. Photograph of type specimen in Kew Herbarium.
Fig. 33. Ray-flower, × 5.
Fig. 34. Disk-flower, × 5.

Plate 7



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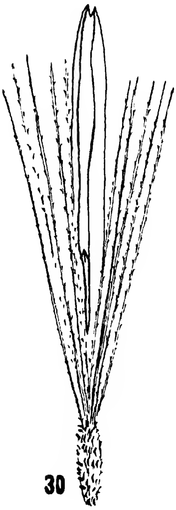

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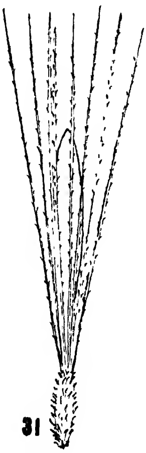

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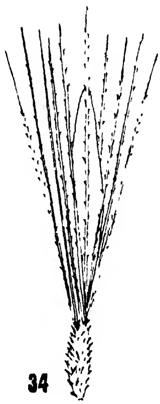

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LARSEN—REVISION OF THE GENUS TOWNSENDIA

STUDIES ON SOUTH AMERICAN LABIATAE. III[1]

SYNOPSIS OF THE GENUS SATUREIA

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SATUREIA (Tourn.) L.

Gardoquia Ruiz et Pavon, Prodr. 86, *pl. 17.* 1794.

Rizoa Cav. in Anal. Cienc. Nat. 3: 133. 1801.

Xenopoma Willd. in Ges. Naturforsch. Fr. Berlin, Mag. 5: 399. 1811.

Thymus Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. 2: 315. 1817 (non L.); Swartz, Prodr. Veg. Ind. Occ. 89. 1788.

Micromeria Benth. in Bot. Reg. 15: sub *pl. 1282.* 1829.

Herbae perennes vel suffrutices in regione nostra, habitu diverso internodiis saepius foliis aequilongis vel brevioribus; foliis maximam partem parvis, non rugosis, venis saepe prominulis, margine integra vel subserrata; floribus in cymulis nunc patentibus nunc densis in foliorum superiorum axillis, rarius solitariis; calycibus tubulosis, fere cylindratis maturis non auctis, saepius 13-venis, venis prominulis, dentibus aequalibus vel patenter bilabiatis, erectis, intus saepius hirsutis; corollae tubo saepius exserto, frequenter subincluso, superne gradatim ampliato, intus frequenter villoso; labro erecto, subintegro vel bifido, breviore, labiolo quam labro paulo longiore, trifido, lobo medio majore et subpatente; staminibus 4, supra tubi medium saepius sitis, didymis, posticis paulo brevioribus, filamentis glabris, connectivo crasso thecas saepius separante, his late divaricatis, rarius subparallelis; stylo paulo exserto, inaequaliter bifido; nuculis oblongis, saepius apice obtusis, rarius apiculatis.

Satureia in the region under consideration is a genus of a certain diversity of habit and flower character, the species of

[1] Issued June 8, 1927

which, however, form a continuous and interlocking series, so that subgeneric lines are difficult to distinguish. As concluded by Briquet,[1] the proposed genera *Gardoquia*, *Xenopoma*, and *Micromeria* are confluent, and the study of species herein described and unknown to him have strengthened this conclusion.

The primary differentiating characters of the genus *Gardoquia* were the long, recurved corolla-tube, the erect emarginate upper lip of the corolla, and the didymous cordate anthers. The genus was maintained by Bentham with the following note "Genus a *Micromeria* non nisi longitudine corollarum, limbique lobis suberectis, distinctum," [2] while *Micromeria* (including *Xenopoma*) in turn was separated from *Satureia* on the basis of the narrower calyx and the character of its venation. With the present series of species these characters are insufficient. *Rizoa* is wholly synonymous with *Gardoquia*, being based on *Gardoquia multiflora* R. & P.

Conspectus Specierum

A. Flores in axillis solitarii, pedicellis calyces subaequantibus vel longioribus elatis, bracteolis absentibus .... *1. S. Brownei*

AA. Flores 3–6 et ultra in axillis vel solitarii, pedicellis quam calycibus brevioribus, bracteolis praesentibus.

B. Herbae fruticulique humiles, altitudine 5–20 cm., floribus in axillis solitariis.

C. Bracteola ad pedicellorum medium sita; folia obovata, margine integra.

D. Calyces 13-venis, dentibus duobus anticis quam posticis subduplo longioribus, erectis .... *33. S. pusilla*

DD. Calyces 15-venis, dentibus subaequalibus, subconniventibus. .... *32. S. Darwinii*

CC. Bracteola ad pedicellorum basim sita; folia ovata vel rotundato-ovata, margine leniter crenata .... *31. S. nubigena*

BB. Suffrutices vel frutices, altitudine 30–200 cm., floribus 1–6 et ultra in axillis.

C. Calyces 1.5–3.5 mm. longi, corollae tubo incluso vel paulo exserto rarius quam calyce duplo longiore.

D. Calyces 1.5–2 mm. longi, corollae tubo incluso.

E. Folia utrinque glabra, anguste lanceolata, acuta...... *37. S. axillaris*

EE. Folia puberula vel pubescentia, oblongâ, obtusa...... *39. S. oligantha*

DD. Calyces 3–3.5 mm. longi, corollae tubo breviter exserto.

E. Folia ovata vel rotundato-ovata, leniter crenata....... *34. S. vana*

EE. Folia lanceolata, oblanceolata vel ovata, subintegra.

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[1] Briquet, J. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 296. 1897.

[2] Bentham, G. in DC. Prodr. 12: 235. 1848.

F. Folia lanceolata, acuta; flores saepius tres in axillis. ....*36. S. simulans*

FF. Folia oblanceolata, oblonga vel ovata, obtusa; flores saepius solitarii.

G. Calyces subturbinati; corollae 7 mm. longae; folia ovalia vel elliptica, 3–5 mm. longa................*38. S. brevicalyx*

GG. Calyces tubulosi; corollae 9 mm. longae; folia oblanceolata vel oblonga, .5–1.5 cm. longa..........*35. S. boliviana*

CC. Calyces 4.5–10 mm. (3.5–4 mm. in *S. rigidula* et *breviflora*), saepius 6–8 mm. longi, corollae tubo saepius longe exserto quam calycibus duplo triplove longiore.

D. Folia 2–5 cm. longa, sat tenuia, ovata vel elliptica, crenato-serrata; flores 3–3.5 cm. longi.

E. Flores pedicellis gracilibus calyces subaequantibus elevati; calyces glabri....................................*2. S. multiflora*

EE. Flores pedicellis quam calycibus brevioribus; calyces extus villosi..*3. S. elliptica*

DD. Folia raro 3 cm. longa, saepius .5–1.5 cm. vel breviora, forma diversiore saepius integra; flores saepius 2–2.5 cm. longi.

E. Folia obovata vel oblanceolata, omnino obtusa; calycis dentes acuminati (acuti in *S. guamaniensis*) etiam subaristati.

F. Folia rhomboideo-obovata, vel subrotunda.

G. Folia rhomboideo-obovata, subtus puberula; flores fere 2 cm. longi.............................*6. S. Matthewsii*

GG. Folia rotunda, subtus parce villosa; flores vix 6 mm. longi. ....*8. S. breviflora*

FF. Folia oblanceolata.

G. Flores in axillis solitarii...................*7. S. guamaniensis*

GG. Flores 3–7 in axillis...........................*5. S. Gilliesii*

EE. Folia elliptico-lanceolata, ovata, vel linearia, raro obtusa; calycis dentes saepius acuti, raro subaristati (*S. Lindeniana, rigidula, glabrata*).

F. Folia 1–2.5 cm. longa, acuta (frequenter obtusa in *S. tomentosa*) pagina superiore subglabra, inferiore incana (sericea in *S. acutifolia*).

G. Calyces vix 5 mm. longi, tubo extus villosissimo..*12. S. discolor*

GG. Calyces 6–8 mm. longi, tubo extus appresso-villoso vel puberulo.

H. Folia ovata, crenata, subtus incano-tomentosa..*9. S. tomentosa*

HH. Folia elliptico-lanceolata, subintegra.

J. Pagina superiore sericea, inferiore tomentosa; margo revoluta...............................*13. S. acutifolia*

JJ. Pagina superiore glabra, inferiore tomentella; margo plana...............................*15. S. Pavoniana*

FF. Folia 2–15 mm. longa utrinque glabra (tomentella in *S. Andrei*) saepius subnitida, venis prominulis, ascendentibus, rectis, parallelis; margo leniter vel nihil revoluta.

G. Folia 5–15 mm. longa.

H. Folia glabra.

J. Calycis dentes subaristati, 2 mm. longi.......*17. S. glabrata*

JJ. Calycis dentes lanceolati, acuti, 1–1.5 mm. longi.
K. Folia utrinque acuta, internodiis multo longiora. .... *18. S. taxifolia*
KK. Folia utrinque obtusa, internodiis subaequilonga. .... *16. S. pallida*
HH. Folia praecipue subtus puberula........ *19. S. Andrei*
GG. Folia 2–5 mm. longa.
H. Folia in basi angustata, haud cordata.
J. Margo integra; calycis dentes erecti........ *20. S. striata*
JJ. Margo serratula; calycis dentes patentes.... *21. S. plicatula*
HH. Folia in basi cordata.
J. Corolla 18–20 mm. longa; calycis dentes tres postices omnino connati........ *23. S. connata*
JJ. Corolla 20–25 mm. longa; calycis dentes tres postices fere ad medium liberi........ *22. S. Jamesoni*
FFF. Folia 2–6 mm. longa, pubescentia, saepe sericea (pagina superiore glabra in *S. Lindeniana*), venis obscuris; margo saepius valde revoluta.
G. Calycis dentes duo antici subulati, fere aristati.
H. Dentes antici 3 mm. longi, posticos superantes. .... *29. S. Lindeniana*
HH. Dentes antici 1.5 mm. longi, posticos aequantes. .... *26. S. rigidula*
GG. Calycis dentes duo antici anguste lanceolati, nullomodo aristati, posticos vix aequantes vel breviores.
H. Folia linearia, utrinque sericeo-villosa; calyces 6 mm. longi........ *27. S. sericea*
HH. Folia ovata, pagina superiore glabrata vel puberula; calyces 5 mm. longi.
J. Foliorum margines valde revolutae; pagina inferiore tomentosa........ *28. S. revoluta*
JJ. Foliorum margines revolutae; pagina inferiore puberula, venis prominulis........ *24. S. argentea*

Sect. Hesperothymus Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Micromeria sect. *Hesperothymus* Benth. Lab. Gen. et Sp. 371. 1834.

Herbae prostratae, caulibus repentibus, foliis ovato-rotundis, subglabris; floribus in foliorum axillis solitatim dispositis, pedicellis calyces maximam partem superantibus, rarius paulo brevioribus, bracteolis duobus nunc praesentibus nunc absentibus; calycibus tubulosis, dentibus erectis subaequalibus, obscure bilabiatis, intus hirsutis; corollae tubo paulo exserto.

This section seems to the present author to be most nearly

allied to sect. *Gardoquia* (*Ellipticae*) through *Satureia Douglasii* (Benth.) Briquet.

1. **Satureia Brownei** (Swartz) Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Herba humilis, caule prostrato, repente, ramis filiformibus, ascendentibus, glabris vel tenuiter pilosis, quadratis, angulis acutis, submarginatis; foliis saepius tenuiter membranaceis minus quam internodiorum longitudine, saepius .5–1 cm. longis, rarius 1.5 cm., ovato-rotundatis, apice obtusioribus, in basi saepius subtruncatis et abrupte in petiolo angustatis, margine sinuato-crenata vel subintegra, omnino glabris vel subtus sparse sed patenter pilosis, petiolo gracillimo laminam aequante vel subnullo; floribus saepius solitariis, rarius duobus in axillis; calycibus glabris, rarius pilosis, 3–4 mm. longis, 13-venis, dentibus .8–1 mm. longis, subaequalibus, ovato-triangulis, acutis, ciliolatis, tubo intus ad dentium basim piloso-annulato, pedicello filiforme calyce aequilongo vel saepius longiore; corollis violaceis, fauce saepe variegatis, 4.5–5 mm. longis, tubo superne ampliato, intus glabro, labro 1 mm. longo, emarginato, labiolo longo 1.5 mm., lobo medio majore, patente, frequenter emarginato; staminibus didymis, supra tubi medium sitis, posticorum filamentis saepius 1 mm. longis, anticorum 2 mm., antheris .7 mm. latis, thecis paulo divergentibus; stylo e corolla subexserto; nuculis .8–1 mm. longis, oblongis, atris.

Subsp. **eubrownei** nom. nov.

Thymus Brownei Swartz, Prodr. Veg. Ind. Occ. 89. 1788, et Fl. Ind. Occ. **2**: 1011. 1800; Benth. Lab. Gen. et Sp., 372. 1834.

Ramulis foliisque fere glabris; petiolis laminas aequantibus vel parte dimidia brevioribus; foliis nec sessilibus; florum pedicellis saepius calycibus aequilongis vel paulo brevioribus.

Specimens examined:

Venezuela: Galipán, 1250 m., June 7, 1885, *Jahn 201* (known as "Poleo") (US)[1]; Paramo de la Sal, 3000 m., Mérida, Sept. 1,

[1] The following abbreviations are used herein: ASP, Academy of Natural Sciences of Philadelphia; FM, Field Museum of Natural History; GH, Gray Herbarium; MBG, Missouri Botanical Garden; NY, New York Botanical Garden; UC, University of California; US, United States National Herbarium.

1921, *Jahn 569, 610* (US); between Antimano and Aguas Negros, 900–1500 m., Apr. 6–7, 1913, *Pittier 6017* (US); prope coloniam Tovar, 1854–5, *Fendler 869* (MBG; GH; NY); Paramo del Tambor, 2400 m., Mérida, Nov. 14, 1921, *Jahn 736, 738* (US); between Colonia Tovar and Lagonazo, in meadows and forests, 1700–2300 m., trailing, forming colonies on road, Feb. 21, 1921, *Pittier 9262* (US); Paramo del Jabón, 3000–3200 m., Oct. 2, 1910, *Jahn 41* (US); Paramo de Piñango, 2600 m., March, 17, 1915, *Jahn 410* (US).

Colombia: Sabana de Bogotá, *Bro. Ariste-Joseph A 903* (US); Cuestá de Tocotá, road from Buenaventura Cali, western Cordillera, 1500–1900 m., Dec. 1905, *Pittier 724* (US); grassy wayside, north of Caramanta, Antioquia, 2000–2200 m., repent herb with odor of *Hedeoma*, Sept. 19, 1922, *Pennell 10777* (US; ASP); forest, 2000–2500 m., Las Minitas, south of Caldás, Antioquia, Sept. 21–22, 1922, *Pennell 10941* (US; ASP); forest, 2000–2500 m., Huila, Aug. 1–8, 1917, *Rusby & Pennell 625* (US; MBG; GH; NY); meadow, 2000–2100 m., Balsillas, Huila, Aug. 3–6, 1917, *Rusby & Pennell 727* (US; MBG; GH; NY); forest, 2600–2900 m., Pinares above Salento, Caldas, Aug. 2–10, 1922, *Pennell 9243* (ASP; US); cliff near Rio San Andreas, 2500–2800 m., Caloguala, Coconuco, El Cauca, June 14, 18, 1922, *Pennell 7157* (US; ASP); Quaranda, July 8, 1876, *Andre 1016*, mountains southeast of Bogotá, 2800 m., June 6, 1875, *Andre 1016* (NY); Popayan, 1600–2000 m., *Lehmann B.T. 1141* (blooms in Feb.) (NY); grassy open, 1500–1600 m., Rio Quindio, Salento, Caldas, July 27–30, 1922, *Killip & Hazen 9040* (US; ASP); around Huila, Rio Paez Valley, El Cauca, 1600–1900 m., "a diminutive plant on wet sand and in moss; fl. purplish pink," Jan. 1906, *Pittier 1242* (US); wet slope, open forest, Susumoco, southeast of Quetamo, 1200–1400 m., Sept. 5, 1917, *Pennell 1735* (cor. violet) (NY); Popayan, *Hartweg 1335* (NY); moist soil near stream, 2000–2200 m., San Isidro, Puracé, El Cauca, June 10–11, 1922, *Pennell & Killip 6430* (US; ASP); field, 2000–2200 m., Santa Elena, above Santuario, Caldas, Sept. 7–13, 1922, *Pennell 10592* ("corolla pale amparo-purple with markings of violet-purple") (US; ASP); thicket below San Jose, 2300–2500 m., San Antonio, El Cauca, July 1, 1922, *Pennell 7654* (US; ASP).

Ecuador: in Andibus Ecuadorensibus, 1857–9, *Spruce 5091* (GH); vic. of Huigra, Sept. 12, 1918, *Rose 22627* (known as "Poleo"; growing in water; strong odor of pennyroyal) (US).

Sect. Gardoquia Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia Ruiz et Pavon, Prodr. 86. *pl. 17.* 1794.

Frutices fruticulive ramulis saepius ascendentibus, brevioribus; foliis saepe fasciculatis, forma diversioribus, maximam partem subintegris, glabris vel pubescentibus; floribus 1–6 in foliorum axillis, pedicellis singulis bracteolis duobus ornatis (*S. multiflora* exclusa) quam calycibus brevioribus elatis; calycibus tubulosis, cylindratis, dentibus maximam partem bilabiatis, tribus posticis anticos superantibus, acutis, etiam subaristatis, intus nudis vel hirsutis, saepius erectis; corollae tubo maximam partem calycem duplo triplove superante.

Gardoquia merges into *Xenopoma* imperceptibly in habit, as illustrated by *S. breviflora* and *S. tomentosa* or *S. boliviana* and *S. Gilliesii*, and in floral characters, as in *S. rigidula, breviflora, argentea, boliviana* and *vana.* The closest alliance between the two sections appears to lie between *S. boliviana* and members of the subsection *Obovatae*, or between *S. breviflora, tomentosa* and *vana.*

A. *Ellipticae*

Foliis 2–5 cm. longis, sat tenuibus, ovalibus vel ellipticis, glabris vel subglabris, crenatis; floribus 3–15 in cymulis in foliorum axillis, corollis 3–3.5 cm. longis.

2. **Satureia multiflora** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia multiflora Ruiz et Pav. Syst. Veg. 149. 1798; Benth. Lab. Gen. et Sp., 398. 1834, et in DC. Prodr. **12**: 235. 1848.

Rizoa ovatifolia Cav. Anal. Cienc. Nat. **3**: 133. 1801.

Frutex aromaticus erectus, ramis altitudine circa 1 m., ramulisque subglabris, purpureis, quadratis, angulis obtusis, internodiis quam foliis sat longioribus, ramulis lateralibus brevibus, gracilibus; foliis membranaceis, 3–5 cm. longis, 1–2 cm. latis, lanceolatis vel ovatis, apice obtusis, in basi rotundatis, margine

convexa, leniter crenata, crenarum culminibus inter se 4–5 mm. distantibus, petiolis gracilibus, 5–12 mm. longis, glabris; floribus 3–7–15 in cymis laxis, raro solitariis, pedunculis gracillimis .5–1.5 cm. longis elevatis, bracteolis parvis 1–1.5 mm. longis subulatis ornatis, pedunculis secondariis .3–1 cm. longis; calycibus membranaceis, 8 mm. longis, in basi paulo angustatis, extus glabris, fauce intus nudis; dentibus circa 1 mm. longis, lanceolatis, acutissimis, subaequalibus, duobus anticis tamen paulo longioribus approximatisque; corollis ut videtur purpureis, 20–30 mm. longis, maximam partem circa 25 mm., tubo extra calycem multo dilato, extus puberulis vel subglabris, intus pilosis, labro longo circa 4 mm., retuso, labiolo aequilongo lobis rotundatis medio lateralibus paulo longiore, in basi angusto; staminibus didymis, paulo supra tubi medium sitis, anticis corolla longioribus, posticis labro subaequilongis, thecis late divergentibus, .7–.8 mm. longis; stylo paulo exserto; nuculis oblongis, fuscis, 1.2 mm. longis.

Specimens examined:

Chili: *unknown collector 245* (NY); 1828–34, *Gay 148* (NY); *Gay* (GH); Chanco, *Reed* (GH); Valdivia, Ufergebüsch des Calle-Calle, Jan. 17, 1898, *Buchtien* (US); Chiquayante (?Chiguailante), Feb. 19, 1892, *Kuntze* (US); Budi, Jan. 1923, *Bro. Claude-Joseph 2016* (US); Temuco, Jan. 1920, *Bro. Claude-Joseph 1043* (US); bushy slopes above Aranco, 50–100 m., March 6, 1925, *Pennell 12953* (GH).

Argentina: Panguipulli, July 1924, *Bro. Claude-Joseph 2627* (US).

3. **Satureia elliptica** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia elliptica Ruiz et Pavon, Syst. Veg. 149. 1798; Benth. Lab. Gen. et Sp. 399. 1834; et in DC. Prodr. **12**: 235. 1848.

Stachys speciosa Hook. Bot. Misc. **2**: 235. 1831.

Frutex erectus odoratissimus, ramosus, ramis teretibus cortice discedente, ramulis glabratis, nitidis, quadratis, angulis acutis; internodiis plerumque foliis aequantibus vel longioribus; foliis 20–30 mm. longis, 10–15 mm. latis, ellipticis, apice obtusis, in basi acutiusculis et ad petiolum 3 mm. longum angustatis,

membranaceis, planis, rugosis, margine supra medium breviter serrata, utrinque glabris vel sparse ciliatis, subtus pallidiore, venis prominentioribus; floribus 4–12 in axillis, pedunculis brevissimis elatis, bracteolis linearibus, quam pedicellis brevioribus ornatis; calycibus 8–11 mm. longis, extus villosis, fauce intus nudis, dentibus duobus anticis fere 3 mm. longis, lanceolato-acuminatis, approximatis, tribus posticis connatis, circa 1 mm. longis; pedicellis 3–5 mm. longis, villosis; corollis coccineis, interdum flavis, 35–40 mm. longis, extus hirtellis, tubo extra calycem multo dilato, intus ad basim hirsuto, labro 4.5–5.5 mm. longo, leniter emarginato, ovato, labiolo subaequilongo, lobo medio lateralibus paulo longiore; staminibus supra tubi medium insertis, didymis, anticis labro longioribus, posticis aequilongis, thecis late divergentibus, 1 mm. longis; stylo e corolla 10 mm. exserto, ramis 1 mm. longis, planis, acutis; nuculis 2 mm. longis, oblongo-obovatis.

Specimens examined:

Peru: Obrajillo, *Wilkes Exp.* (US); rock ledges at cascades of Rio Chillon, above Obrajillo, Lima, 3100–3300 m., June 13–23, 1925, *Pennell 14401* (GH); abundant on open rocky slopes, Huaros, Lima, 3200–3600 m., June 23, 1925, *Pennell 14734* (GH).

4. **Satureia Loesneriana** Mansfeld in Bot. Gart. Berlin-Dahlem, Notizbl. 9: 287. 1925.

"Frutex 1 m. altus. Rami juniores quandrangulares, brevissime puberuli. Foliorum lamina 9–22 mm. longa, 3–8 mm. lata, elliptica vel rarius oblonga vel obovata, apice acuta, brevissime mucronulata, basi in petiolum brevissimum angustata, margine ± remote et breviter dentata vel integra, subrevoluta vel plana, penninervis, utrinque glanduloso-punctata, nervis utrinque prominulis (vel supra vix conspicuis), initio utrinque breviter puberula, postea praecipue supra glabrescens vel glabra. Verticillastri usque 16-flori. Calyx circ. 5.5 mm. longus, bilabiatus, labio tridentato dentibus 0.6 mm. longis, labiolo dentibus 1.5 mm. longis, dentibus extus et intus brevissime puberulus. Corolla circ. 15 mm. longa, labio sat profunde emarginato 2.5 mm. longo, labiolo tripartito 3 mm. longo, extus pubescens, tubo intus antice piloso. Stamina didynamia ± exserta, filamenta antica 5, postica 3.5 mm. longa, antheris divergentibus. Stylus exsertus.

"Peru: Prov. Huamachuco, Depart. Libertad, über Huamachuco, Grassteppe mit eingestreuten immer oder regengrünen Straüchern, 3400–3500 m. ü. M., 1 m. hoher Strauch, Blüten violett (Fl. 3. VII. 1914.—Weberbauer n. 7008!).

"Die Art gehört in die Nähe von *S. elliptica* (Ruiz et Pav.) Briq. und *S. Matthewsii* Briq., die erstere Art weicht schon durch eine viel längere Korolla ab, die letztere besitzt nach der Beschreibung eine längere, innen kahle Krone und kürzere Kelchzähne."

Mihi ignota; ad *S. ellipticam* affinis videtur. Inquire praeterea in *S. rugosani* Briq. in Engler u. Prantl. Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

B. *Obovatae*

Foliis saepius 1–1.5 cm. longis, obovatis vel oblanceolatis, glabris vel pubescentibus, margine integra vel crenata; floribus 1–6 in verticillastris sat densis in foliorum axillis, corollis circa 2–2.5 cm. longis (6 mm. in *S. breviflora*).

5. **Satureia Gilliesii** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia Gilliesii Grah. in Edinb. Phil. Jour. **1831**: 377. Sept. 1831; Benth. in DC. Prodr. **12**: 235. 1848.

G. chilensis Benth. in Hook. and Arn. Bot. Beechey's Voyage, 58. 1841.

Satureia chilensis Briq. in Ann. Conserv. et Jard. Bot. Genève **2**: 191. 1898.

Fruticulis suaveolens altitudine ad 1–1.5 m., caulibus in basi lignosis, procumbentibus, ramis teretibus, cortice discedente, ramulis pubescentibus, quadratis, angulis obtusis, internodiis ramulorum sterilium quam foliis brevioribus, his itaque densis, eis fertilium sat distantibus; foliis 7–10 mm. longis, rarius 10–20 mm., anguste oblanceolatis apice rotundatis, in basi ad petiolum brevem attenuatis, margine integra, revoluta, utrinque subglabris, rarius patenter puberulis; floribus 3–7 saepius circa 5 in axillis, pedunculis .5–2 mm. longis, bracteolis foliis conformalibus minoribus; calycibus 7–12 mm. longis, in basi paulo angustatis, extus saepius puberulis, fauce intus nudis, dentibus 2–3 mm. longis, lanceolato-acuminatis, subaristatis, duobus anticis quam

posticis tribus saepe longioribus approximatisque; corollis circa 12–18 mm. longis, coccineis, extus pubescentibus, tubo ampliato, intus pilosis, labro longo 2–3 mm., emarginato, sinu .5 mm. profundo, labiolo paulo longiore, lobo medio lateralibus superante, in basi angustato; staminibus didymis, supra tubi medium sitis, posticis vix e tubo exsertis, anticis corolla aequilongis, thecis late divergentibus, .5 mm. longis; stylo paulo exserto; nuculis non visis.

Specimens examined:

PERU: *Dombey 291* (GH).

CHILI: Valparaiso, June 1885, *Rusby 1061* (GH); Valparaiso, July 1851, *Gillies* (GH); Valparaiso, Apr.–July, 1856, *Harvey* (GH); ex regione inferiori Andium Chilensium juxta tepidaria Cauquenes, 3000–5000 m., May 14–17, 1882, *Ball* (GH; NY); Maule, *Reed* (GH); Valparaiso, *Arnott* (NY); no locality, 1884–85, *Statin* (NY); no data, *Wilkes Exp.* (ASP; US; NY); Santiago, montaña, Dec. 5, 1920, *Bro. Claude-Joseph 1321* (US); Valparaiso, *Eights* (US); Valparaiso, in Gebüschen, Sept. 5, 1895, *Buchtien* (US); Isle of St. Marys, *Eights* (US); mountains east of Santiago, 769 m., Dec. 27, 1900, *Hastings 310* (US; NY; UC); Santiago, Jan. 1919, *Bro. Claude-Joseph 840* (US); Valparaiso, Feb. 1922, *Bro. Claude-Joseph 1619* (US); Rio Blanco, Jan. 1924, *Bro. Claude-Joseph 2479* (US); Valparaiso, *Mertens* (MBG); Santiago, Jan. 1920, *Bro. Claude-Joseph 956* (US); near Valparaiso, June 1885, *Rusby 1061* (ASP; US); no data, *Styles* (ASP); in fruticetis apricis collium St. Jago, Quillota, Feb., 1829, Sept.–Oct., 1829, *Bertero 291*, *1015* (MBG; GH; NY); Prov. Curicó, hacienda Monte Grande, 1000 m., Dec., 1924, *Werderman 547* (UC); Cerro Echaurrina (San Fernando), Prov. Colchagua, Oct., 1925, *Montero 13* (GH).

6. **Satureia Matthewsii** Briq. in Ann. Conserv. et Jard. Bot. Genève. 2: 189. 1898.

Frutex ut videtur elatus, ramis ascendentibus, teretibus, glabris, mox ligneis, ramulis gracilibus, glabris, nodis inter se 3–5 mm. vel in ramulis sterilibus 1–1.5 cm. distantibus; foliis 1–1.5 cm. longis, elliptico- vel rhomboideo-obovatis, frequenter subrotundatis, apice saepius obtusis, in basi rotundato-extenuatis,

utrinque glabris, dense glanduloso-punctatis, margine integra, revoluta; verticillastris 1–3 floribus, in foliorum ad ramulorum apices axillis approximatis, bracteis lineari-spatulatis, quam pedicellis paulo longioribus; calycibus fere 1 cm. longis, anguste tubulosis, extus puberulis, fauce intus nudis, patenter bilabiatis, labia superiore erecta, 3 mm. longa, dentibus subulatis ad medium connatis, inferiore 2.5 mm. longa, dentibus patentibus, subulatis, ad basim connatis, pedicellis 2 mm. longis elatis; corollis circa 2 cm. longis, tubo 18 mm. longo, intus subnudo, extus hirtello, superne ampliato, labro 3 mm. longo, emarginato, labiolo paulo longiore, lobo medio majore; staminibus supra tubi medium sitis, didymis, breviter exsertis, thecis valde divergentibus; stylo 5–6 mm. longo, exserto; nuculis non visis.

Specimens examined:

Peru: Near San Felipe, Cajamarca, 1950 m., May, 1915, *Weberbauer 7109* (FM).

7. **Satureia guamaniensis** Mansfeld in Bot. Gart. Berlin-Dahlem Notizbl. 9: 286. 1925.

S. obovata Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. 3a, 300. 1897, non Lag. Gen. et Sp. Nov. 18. 1816.

Gardoquia obovata Ruiz et Pavon, Syst. Veg. 150. 1798; Benth. Lab. Gen. et Sp., 403. 1834, et in D.C. Prodr. 12: 236. 1848.

Frutex altitudine circa 1 m., ramis teretibus, ramulis quadratis, pubescentibus glabratisve, nodis approximatis; foliis 5–7 mm. longis, obovatis oblanceolatisve, in basi ad petiolum brevissimum angustatis, utrinque glabris, subtus pallidioribus; margine integra, revoluta; floribus in axillis solitariis, bracteolis foliis conformalibus, quam pedicellis longioribus; calycibus 5–6 mm. longis, extus glabratis, fauce intus hirsutis, dentibus subaequalibus, lanceolatis, acutiusculis, labia postica tamen longiore, ore itaque obliquo, pedicellis 2 mm. longis elatis; corollis coccineis, 22–24 mm. longis, tubo extra calycem valde dilato, fauce diametro 8 mm., extus pubescentes, intus leniter piloso, labro 5 mm. longo, emarginato, sinu 1 mm. profundo, labiolo aequilongo, lobis aequalibus; staminibus paulo supra tubi medium sitis, didymis, anticis e corolla 5–6 mm. exsertis, posticis e tubo exsertis; thecis late divaricatis, .6 mm. longis; stylo e corolla 8 mm. exserto; nuculis non visis.

S. guamaniensis, as suggested by its author,[1] is scarcely separable from *Gardoquia obovata* R. & P.

Specimens examined:

PERU: between Cuancabamba and Oyavaca, 3200 m., May, 1912, *Weberbauer 6323* (FM, type collection of *S. guamaniensis* Mansf).

8. Satureia breviflora Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia breviflora Benth. Lab. Gen. et Sp. 401. 1834, et in DC. Prodr. **12:** 237. 1848.

Frutex ramulis quadratis, pubescentibus, angulis obtusis, internodiis saepius folia superantibus; foliis .5–1 cm. longis, rotundatis vel rotundato-ovatis, obtusis, subsessilibus, pagina superiore viride, puberula, venis impressis, inferiore cano-tomentosa venis prominenter costatis, margine subintegra vel frequenter dentato-crenata, crenis fere 1 mm. altis; floribus 3–6 in axillis, brevissime pedunculatis, verticillastris saepius ad ramulorum brevium lateralium extremitates congestis, foliis floralibus calyces subaequantibus, bracteolis linearibus 1–2 mm. longis; calycibus 3.5–4 mm. longis, extus hirtellis, fauce intus nudis, dentibus 1–1.5 mm. longis, anguste lanceolatis, acutissimis, duobus anticis quam posticis paulo longioribus, pedicellis gracilibus circa 1 mm. longis; corollis 6–7 mm. longis, tubo intus ad staminum anticorum bases piloso, labro 1 mm. longo, emarginato, labioli lobis subaequalibus, fere 2 mm. longis, medio paulo majore; staminibus in fauce sitis, didymis, vix e tubo exsertis, thecis paulo divergentibus; stylo e tubo paulo exserto; nuculis non visis.

Specimens examined:

ECUADOR: Quitensian Andes, *Jameson* (US).

C. *Discolores*

Foliis saepius 1–2 cm. longis, lanceolatis vel elliptici-lanceolatis, pagina superiore glabra, sericea vel villosula, inferiore canotomentosa vel tomentella, margine saepius integra (crenata in

[1] "Die am nächsten stehende Art *S. obovata* (Ruiz et Pav.) Briq. unterscheidet sich nach der (nicht mehr ausreichenden) Beschreibung nur durch längere Blätter, grau behaarte zweige an der Basis behaarte kelch und innen Kahle Krone."—Mansfeld, *l.c.*

S. tomentosa); floribus 1–6 in verticillastris sat densis in foliorum axillis; corollis 1.5–3 cm. longis.

9. **Satureia tomentosa** Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia tomentosa Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. **2**: 314. 1817; Benth. in DC. Prodr. **12**: 237. 1848.

Frutex ramosus altitudine ad 1 m., ramis duris, ascendentibus, subteretibus, cortice saepe discedente, internodiis saepius 2–3 cm. longis, ramulis gracilibus, ascendentibus, quadratis, angulis obtusis, superne cano-puberulis vel tomentosis, internodiis maximam partem quam foliis brevioribus; foliis 1–1.5 cm. longis, saepius ovatis, frequenter rotundatis vel ellipticis, apice acutis vel obtusis, in basi cuneato-angustatis, margine revoluta, saepius obscure crenata, pagina superior rugosa, nunc glabra nunc hirtella, inferiore albo-tomentosa, rarius villosa, venis subtus prominentioribus, petiolis 1–2 mm. longis elatis; verticillastris saepius 3–6-floribus, rarius breviter pedunculatis, in axillis foliorum superiorum dispositis, his calyces paulo superantibus; calycibus 7 mm. longis, extus molliter appresso-villosis, sub-bilabiatis, labia superiore longiore, dentibus supra medium connatis, vix .5 mm. longis, triangulo-lanceolatis, inferiore 2 mm. longa, dentibus liberis, lanceolato-subulatis, approximatis; pedicellis 2 mm. longis elatis; corollis rubris, 2–3 cm. longis, extus pubescentibus, tubo superne gradatim ampliato, intus tenuiter piloso, labro subrecto 5 mm. longo, emarginato, labiolo subaequilongo, lobo medio lateralibus nunc aequilongo nunc fere duplo longiore; staminibus breviter exsertis, didymis, supra tubo medium sitis, thecis divergentibus; stylo exserto, circa 5 mm. longo; nuculis atris, oblongis, angustis, 1.5 mm. longis.

A species of some variability in habit and pubescence and to which *S. Kunthii* (*grandiflora*), *elegans*, and *pulchella* may apparently be referred. Considering the variability of the species as shown by the fairly large series of specimens examined, there is nothing in Kunth's descriptions to permit of their differentiation.

Specimens examined:

?Colombia: Tobacumdo, June 9, 1876, *Andre 3598* (NY); no data, *Andre K 460* (NY).

ECUADOR: Banos, Prov. Tunguragua, 2000 m., *Tate 607* (US); ad sepes, in planitie Rumibamba, Quito, *Hartweg 1340* (NY); ad pontem Guapalo prope Quito *Hartweg 1339* (NY); Punin, Quebrada Chalan, 2779 m., Oct. 28–Nov. 4, 1923, *Anthony & Tate 423* (US); ad vicum Guapalo prope Quito, 2076 m., *Jameson 659* (ASP); no data, *Jameson* (US); Quitensian Andes, 1855, *Couthouy* (GH); Riobamba, Aug. 11, 1920, *Holway 870* (US; GH); bei Riobamba, Ambato, Gualabamba, 1800–2700 m., Nov. 25, 1880, *Lehmann 149* (US).

PERU: thickets and stream banks, 15 mi. southeast of Huanuco, 3230 m., May 31–June 3, 1922, *Macbride & Featherstone 2084* (forma villosa) (MBG; FM).

10. Satureia thymoides Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia thymoides Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. **2:** 314. 1817; et Benth. in DC. Prodr. **12:** 238. 1848.

"Frutex ramosissimus; ramis tetragonis, pubescentibus. Folia opposita, brevissime petiolata, ovata, subcordata, acuta, subserrata, margine revoluta, venosa, supra glabriuscula, subtus cano-pubescentia, tres lineas longa, duas lineas lata. Petioli pubescentes. Flores verticillati, pedunculati, semipollicares; verticillis multifloris, distantibus; internodiis quinque aut novem lineas longis. Calyx tubulosus, decemsulcatus, quinque-dentatus, pubescens; dentibus inaequalibus, acuminato-subulatis. Corolla calyce triplo longior, flava (?) ex Bonpl., pubescens; tubo interne pubescente; fauce longissima, inferne barbata; limbo bilabiato, purpureo-maculato; labio superiore emarginato; inferiore trifido; laciniis obtusis. Stamina quatuor, didynama, distantia, subinclusa. Filamenta glabra. Antherae arcuatae. Stylus exsertus, glaber. Stigma bifidum. Fructus ignotus. Crescit in Andibus Quitensibus?"

Ut videtur ad *Discolores* referenda et ab affinibus imprimis foliis subsessilibus, ovatis, subcordatis, parvis (3 lin. longis) separanda est.

11. Satureia foliolosa Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia foliolosa Benth. in DC. Prodr. **12:** 238. 1848.

"foliis parvis subsessilibus ovatis obtusis integerrimis supra pallidis puberulis glabratisve subtus canescenti-tomentellis, verticillastris 2–6-floris, calyce subsessili hirsutissimo dentibus acutissimis patentibus tubo suo vix brevioribus. Ad Chapada de Santa Martha (Purdie!). Frutex decumbens, ramosissimus, dense foliosus. Rami nunc pilis longis hirsutissimis, nunc fere glabri. Folia 2–3 lin. longa, floralia conformia. Calyces 2 lin. longi, latiuscule campanulati, incurvi. Corolla villosa, semipollicaris? ei *G. discoloris* similis videtur, sed in specimine nondum aperta (v.s.)."

Planta mihi ignota similis *S. discolori* est, tamen ut videtur foliis ovatis, subsessilibus, minoribus (2-3 lin. longis) et ramis nunc fere glabris, nunc densissime pilis longis ornatis imprimis differt.

12. Satureia discolor Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia discolor Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. **2**: 312. 1817; Benth. in DC. Prodr. **12**: 238. 1848.

Frutex ramosissimus, ramis teretibus, duris, cortice discedente, ramulis quadratis, puberulis, nodis approximatis; foliis densis, membranaceis, 5–10 mm. longis, maximam partem anguste ellipticis, rarius lanceolatis vel oblanceolatis apice acutiusculis, in basi ad petiolum brevem angustatis, margine integra, revoluta, pagina superiore subglabra nec nitida, inferiore patenter pallidiore, albo-tomentella, venis prominentioribus; floribus in axillis solitariis, bracteolis foliosis sed minoribus; calycibus 4.5–5 mm. longis, extus piloso-villosis, fauce intus subglabris, dentibus tubum aequantibus, lanceolato-acuminatis, approximatis, tribus posticis connatis, lanceolatis, acutis, 1.5 mm. longis, omnibus pubescentibus, vix villosis, pedicellis gracilibus, 2 mm. longis, corollis purpureis (Bonpland), 14–15 mm. longis, extus villosulis, tubo extra calycem dilato, intus ad faucem piloso; labro fere 2 mm. longo, emarginato, sinu .5 mm. profundo, labiolo aequilongo, lobis subaequalibus; staminibus didymis supra tubi medium sitis, anticis longioribus, omnibus inclusis, thecis divergentibus, .6 mm. longis; stylo e corolla vix exserto; nuculis non visis.

Specimens examined:

Venezuela: prope coloniam Tovar, 1854–5, *Fendler 2058*

(MBG; GH); Silla de Caracas, 2600 m., Apr. 27, 1884, *Jahn 288* (US); Silla de Caracas, 2000–2640 m., Dec. 26–29, 1918, *Pittier 8360* (US); Silla de Caracas, 2461 m., May 21, 1874, *Kuntze 1640* (1–3 ft. tall; fl. violet) (US; NY).

13. Satureia acutifolia Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia acutifolia Benth. in DC. Prodr. **12:** 236. 1848.

Frutex ut videtur, ramulis quadratis, sericeo-villosis, ad extremitates albis, mox fuscis, ramorum internodiis foliorum longitudine subaequilongis, sed foliis ramulorum fertilium (vel ? juvenilium) fasciculatis; foliis 1.5–3 cm. longis, elliptico-lanceolatis, utrinque acutis vel in basi angustatis, margine patenter revoluta, integra, pagina superiore sericeo-villosa, inferiore albo-tomentosa, petiolis 1–2 mm. longis elatis; floribus tribus in axillis, bracteolis 2–3 mm. longis subtentis, calycibus 8 mm. longis, extus sericeis, 13-venis, labiis 2 mm. longis, dentibus duobus anticis anguste lanceolatis, acuminatis, liberis, tribus posticis supra medium connatis; pedicellis 1–2 mm. longis elatis; corollis ut videtur rubris, 2.5 (?–3.0) cm. longis, extus sparse villosis, tubo superne gradatim ampliato, labro erecto, fere 5 mm. longo, labiolo subaequilongo; staminibus ut videtur inclusis, stylo paulo exserto; nuculis non visis.

Specimens examined:

PERU: *? Matthews* (NY).

14. Satureia mantaroensis Mansfeld in Bot. Gart. Berlin-Dahlem, Notizbl. **9:** 287. 1925

"Frutex usque 2 m. altus. Rami juniores quandrangulares, dense puberuli. Foliorum lamina 7–14 mm. longa, 5–7 mm. lata, elliptica vel subobovata vel oblonga, supra brevissime puberula subtus pallidior, tomentella, plana, nervis utrinque prominulis, apice acuta vel obtusa, basi angustata, margine integerrima vel vix conspicue et remote dentata; petiolus circ. 2 mm. longus, tomentellus. Verticillastri plerumque biflori, foliis floralibus conformibus. Pedicelli circ. 2 mm. longi, cano-puberuli. Calyx 8 mm. longus extus cano-puberulus, dentibus intus breviter pilosis, bilabiatus (3/2), dentes labii circ. usque ad medium con-

nati, dentes labioli paullo breviores, liberi. Corolla 20–23 mm. longa (labio emarginato circ. 5 mm. longo, labiolo trilobato 4.5 mm. longo), extus dense pubescens, intus tubo antice piloso et paulo supra basin annulo pilorum vestita. Stamina didynamia, anticis longioribus circ. 9 mm. longis, posticis 4–5 mm. longis, antheris divergentibus, anticis et stylo exsertis. Stylus 32 mm. longus.

"Peru: Depart. und Prov. Huancavelica, südliche Talwand des Mantaro über Iscuchaca, Grassteppe mit eingestreuten Sträuchern, 3600 m.u.M., bis 2 m. hoher Strauch mit roten Blüten (Fl. 15. VI. 1910.—Weberbauer n. 5677!).

"Die Art steht nach der Länge der Krone zwischen *S. Pavoniana* Briq. (*Gardoquia incana* Ruiz et Pav.) und *S. discolor* (Kunth) Briq. in der Mitte; *S. discolor* hat ferner eingeschlossene Stamina und inne kahle Kronröhre, *S. Pavoniana* oberseits bleiche Blätter (nach der nicht mehr ausreichenden Beschreibung). *S. thymoides* (Kunth) Briq. weicht durch den fast herzförmigen Blattgrund und zurückgerollten deutlich gezähnten Blattrand ab, steht aber sonst besonders im Blütenbau der *S. mantaroënsis* wohl am nächsten."

Ex descriptione ab *S. Pavoniana* vix distincta videtur.

15. **Satureia Pavoniana** Briq. in Ann. Conserv. et Jard. Bot. Genève **2:** 189. 1898.

Gardoquia incana Ruiz et Pavon, Syst. Veg. 150. 1798; Benth. Lab. Gen. et Sp., 401. 1834, et in DC. Prodr. **12:** 237. 1848.

Frutex altitudine 30 cm.–2 m., caulibus erectis vel ascendentibus, lignosis, subteretibus, cortice discedente, internodiis saepius 3–4 cm. longis, ramulis saepius 5–10 cm. longis, gracilibus, canescentibus, ascendentibus, internodiis quam foliis saepius brevioribus; foliis 1–1.5 cm. longis, ellipticis, rarius ovatis, acutis, in basi angustatis, margine maximam partem integra planaque, rarius denticulata vel subrevoluta, pagina superiore pallidiore, non rugosa sed venis tamen saepe prominentioribus, inferiore dense cano-tomentella, petiolis 1–2 mm. longis, verticillastris 1–3-floribus, decussatim instructis in foliorum superiorum axillis dispositis, his calyces paulo superantibus, bracteolis linearibus ornatis; calycibus incanis, paulo arcuatis, 6–8 mm. longis, subbi-

labiatis, fauce intus subnudis, labiis circa 1.5 mm. longis, dentibus lanceolato-subulatis, posticis tribus ad medium connatis, anticis fere liberis brevioribus, pedicellis 2–3 mm. longis elatis; corollis rubris, fere 3 cm. longis, arcuatis, extus pubescentibus, tubo superne gradatim ampliato intus infra staminum praecipue anticorum bases piloso, labro subrecto, 5 mm. longo, emarginato, labiolo subaequilongo, lobo medio longiore; staminibus didymis, omnibus breviter exsertis supra tubi medium sitis; stylo circa 5 mm. exserto; nuculis circa 1.5 mm. longis, oblongis, angustis, atris.

Specimens examined:

Peru: Yanahuanca, densely shrubby northeastern slope, 3076 m., June 16–22, 1922, *Macbride & Featherstone 1196* (FM; MBG); sunny blackberry patch, Mito, 2769 m., July 8–22, 1922, *Macbride & Featherstone 1411* (FM; MBG); dry hills, Oroya, Lima, 3076–3384 m., 1919, *Kalenborn 82* (US; MBG); no data, *Dombey* (GH).

D. *Striatae*

Foliis 2–15 mm. longis, forma diversis, utrinque glabris, saepius subnitidis, venis prominulis, ascendentibus, rectis, parallelis, margine subintegra, floribus solitariis vel tribus in foliorum axillis; corollis 1.5–3 cm. longis.

16. Satureia pallida sp. nov.

Frutex ramosus, altitudine ut videtur circa 1 m., ramis ascendentibus, teretibus, lignosis, cortice discedente, ramulis divaricatis, glabris, quadratis, angulis acutis, internodiis foliis subaequilongis vel brevioribus; foliis 1–1.5 cm. longis, maximam partem ovalibus vel elliptico-oblongis, obtusis, in basi saepius rotundatis, utrinque glabris et pallidioribus, margine leniter revoluta, integra, petiolis 1–2 mm. longis elatis; floribus 1–3 in foliorum supremorum axillis dispositis; calycibus in speciminibus visis 8–9 mm. longis, puberulis, subbilabiatis, fauce intus nudis, labiis fere 1.5 mm. longis, dentibus posticis tribus ad medium connatis, anticis liberis, omnibus subulatis, acutiusculis, pedicellis 3–4 mm. longis, bracteolis linearibus ad medium ornatis elatis; corollis 2.5 cm. vel ultra longis, arcuatis, extus pubescentibus, tubo superne gradatim dilato, intus infra staminum praecipue

anticorum bases piloso, labro subrecto, 4 mm. longo, emarginato, labiolo subaequilongo, lobo medio longiore; staminibus didymis, omnibus breviter exsertis, supra tubi medium sitis; stylo exserto; nuculis circa 1.5 mm. longis, ellipticis, atris.

A species allied to *S. Pavoniana* and at first thought to be a glabrous variety of it. However, study of other members of the type collection, together with an unnumbered collection by Bang at the New York Botanical Garden which is apparently conspecific, suggests a range of leaf variation too great to permit of reference to *S. Pavoniana.* The flowers of the two species are very similar, differing chiefly in the size of the calyces and in the more acute, even acuminate, calyx teeth of *S. pallida.* The species is intermediate with the groups *Discolores* and *Striatae.*

Specimens examined:

Bolivia: *Bang,* no data (NY); Turedon, Bolivian plateau, 1891, *Bang 1127* (US; NY, type; GH).

17. Satureia glabrata Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia glabrata Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. **2:** 313. 1817; Benth. in DC. Prodr. **12:** 236. 1848.

Frutex ramosissimus, ramis teretibus, cortice discedente, ramulis densis quadratis patenter pubescentibus; foliis confertis, 6–9 mm. longis, ellipticis vel elliptico-lanceolatis utrinque acutiusculis, subsessilibus, utrinque glabris, pagina superiore nitida, inferiore pallidiore, punctata, venis prominentibus, margine subintegra, vix revoluta; floribus tribus in axillis, rarius solitariis pedunculis subnullis, bracteolis primis omnino foliosis, secundariis conformalibus, minoribus ornatis; calycibus 7 mm. longis, extus glabris, fauce intus leniter hirsutis, dentibus subaequalibus, fere 3 mm. longis, longe acuminatis, ore obliquo, pedicellis 2–2.5 mm. longis; corollis 27 mm. longis, extus pubescentibus, intus glabris, labro 7 mm. longo, emarginato, sinu 1 mm. profundo, labiolo paulo breviore, lobo medio lateralibus subduplo longiore; staminibus didymis, supra tubi medium sitis, posticis labro paulo brevioribus, anticis corollam superantibus; thecis late divergentibus, .7–.8 mm. longis; stylo e corolla 7–8 mm. exsertis; nuculis non visis.

Specimens examined:
ECUADOR: vic. of Tablón de Oña, Sept. 27, 1918, *Rose 23083* (US).

18. Satureia taxifolia Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia taxifolia Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. **2**: 312. 1817; Benth. in DC. Prodr. **12**: 236. 1848.

Thymus taxifolius Willd. ex Benth. in Linnaea **11**: 342. 1837.

Frutex ramosissimus altitudine 1–2 m., ramis teretibus, cortice discedente, ramulis densis, quadratis, puberulis; foliis densis, ad ramorum extremitates saepius imbricatis, maximam partem 10–12 mm. longis, saepius lanceolato-oblongis, frequente oblanceolatis etiam lineari-oblongis, apice obtusis, rarius acutiusculis, in basi ad petiolum brevissimum angustatis, utrinque glabris, pagina superiore nitida, inferiore pallidiore, venis prominentibus, margine revoluta, integra vel praecipue ad apicem obscure serrata; floribus in axillis solitariis, rarius didymis, bracteolis linearibus quam pedicellis duplo longioribus ornatis; calycibus 6–7 mm. longis, cano-puberulis, fauce intus nudis, dentibus subaequalibus, circa 1 mm. longis, lanceolatis, acutiusculis, labia postica longiore, ore itaque obliquo, pedicellis 1 mm. longis; corollis coccineis, 25–27 mm. longis, extus pubescentibus, tubo extra calycem multo dilato fauce intus sparse piloso, labro 3–3.5 mm. longo, emarginato, sinu .5 mm. profundo, labiolo aequilongo, lobis subaequalibus; staminibus supra tubi medium sitis, didymis, anticis corolla longioribus, posticis e tubo exsertis; thecis late divaricatis, .6 mm. longis; stylo e corolla 4–5 mm. exserto; nuculis non visis.

Specimens examined:
ECUADOR: Loja, between San Lucas and Oña, 2200–3100 m., Sept. 7, 1923, *Hitchcock 21527* (US); Loja, between La Toma and Loja, 1800–2600 m., Sept. 4, 1923, *Hitchcock 21437* (US); in montibus, Loja, *Hartweg 808* (cited by Bentham as *888*) (NY); vicinity of Loja, Sept. 29–Oct. 3, 1918, *Rose 23279* (US).

19. Satureia Andrei sp. nov.

Frutex habitu foliisque fere *S. glabratae*, foliis ramulisque tamen utrinque tomentellis, eis 10–12 mm. longis, oblanceolatis,

obtusis, in basi angustatis, venis prominulis, margine subserrata, subrevoluta, petiolis subnullis; floribus in axillis solitariis, bracteolis deciduis ornatis; calycibus 5.5 mm. longis, extus puberulis, 13-venis, dentibus 1 mm. longis, lanceolatis, acutis, subaequalibus sed tamen leniter bilabiatis, intus hirsutis; corollis extus villosis ut videtur circa 15 mm. longis, antheris generis vix exsertis, stylo exserto 4–5 mm.; nuculis non visis.

Specimens examined:

Colombia: Cisne, Oct. 30, 1876, *Andre 4331* (NY, type, haud satis est).

20. **Satureia striata** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia striata Ruiz et Pavon, Syst. Veg. 148. 1798; Benth. Lab. Gen. et Sp. 404. 1834; et in DC. Prodr. **12**: 238. 1848.

Frutex strictus, altitudine .5–2 m., caule in basi crasso, duro, terete, striato, ramis ramulisque gracilibus, confertis, fastigiatis, subquadratis, pubescentibus; foliis densis, subconduplicatis, 2–5 mm. longis, plerumque ovatis, obtusis, in basi rotundato-angustatis, vix cordatis, glabris vel vena media subtus ciliata, pagine superiore nitida, venis impressis, inferiore punctata, venis pulchre elevato-striatis lateralibus circa 4–6, pedicellis subnullis, pubescentibus; floribus in axillis solitariis, bracteolis foliis conformalibus; calycibus 6–7 mm. longis, profunde sulcatis, 13-venis, glabris, fauce intus nudis, dentibus 1 mm. longis, subaequalibus, lanceolatis, acutis, patentibus, subrecurvis, pedicellis gracilibus 2 mm. longis; corollis rubris, 20–25 mm. longis, extus molliter villosis, tubo extra calycem multo ampliato, intus infra labiolum pilosis, labro erecto, 5–6 mm. longo, emarginato, sinu 1 mm. profundo, labiolo 4 mm. longo, lobis subaequalibus, rotundatis, medio patentibus; staminibus didymis, posticis e tubo paulo exsertis, anticis labrum subaequantibus, omnibus supra tubi medium sitis; thecis divergentibus, .5–.6 mm. longis; stylo e corolla 3 mm. exserto; nuculis non visis.

Specimens examined:

Peru: Mito, July 23–Aug. 14, 1922, *Macbride & Featherstone 1734* (FM; MBG); 12 mi. south of Panao, 3,076 m., July 4–10, 1922, *Macbride & Featherstone 2213* ("a common hillside shrub") (FM; MBG).

21. Satureia plicatula sp. nov.

Suffrutex procumbens, caule duro, ramisque teretibus, ramulis subquadratis, puberulis, nodis approximatis, saepe in ramulis lateralibus brevibus confertissimis; foliis 3–5 mm. longis, ovatis, apice acutis, subacuminato-mucronulatis, in basi rotundatis, subsessilibus, utrinque subglaucis et minutissime puberulis, venis paginae superioris leniter impressis, inferioris pulchre elevatis, lateralibus parallelis plicatulis, media prominentiore, margine serratula nec revoluta; floribus in axillis solitariis, bracteolis pedicellis aequilongis, lineari-carinatis, mox deciduis ornatis, calycibus 6 mm. longis, extus pubescentibus, fauce intus hirsutis, dentibus anticis 1.3 mm. longis, subulatis, patentibus, tribus posticis connatis, subulatis, subpatentibus, pedicellis 2–2.5 mm. longis; corollis coccineis 25 mm. longis, tubo extra calycem multo dilato, extus pubescente, intus praecipue ad staminum bases piloso, labro 4.5 mm. longo, emarginato, sinu .5 mm. profundo, labiolo paulo longiore, lobo medio lateralibus duplo longiore, rotundato, in hoc specimine emarginato, in basi angustato; staminibus paulo supra tubi medium sitis, didymis, omnibus e tubo exsertis, anticis corolla subaequilongis; thecis divergentibus, .7 mm. longis, stylo e corolla 5 mm. exsertis; nuculis non visis.

Specimens examined:

PERU: pendant from river cliff ledges, 2153 m., Llata, Aug. 21, 1922, *Macbride & Featherstone 2238A* (FM, TYPE).

22. Satureia Jamesoni Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia Jamesoni Benth. Lab. Gen. et. Sp. 404. 1834, et in DC. Prodr. **12**: 239. 1848.

Frutex ut videtur strictus ramosissimus altitudine .5–1 m., caule in basi crasso, duro, terete, striato, ramis ramulisque gracilibus, confertis, fastigiatis, subquadratis, pubescentibus; foliis parvis, confertis, 2 mm. longis, plerumque ovatis, obtusis, in basi rotundato-angustatis, utrinque tenuissime puberulis, subconduplicatis, margine revoluta integra, venis subtus prominentioribus, petiolis minimis, floribus solitariis vel tribus in axillis, bracteolis foliis conformalibus minutissimis; calycibus 5–7 mm. longis, profunde sulcatis, 13-venis, subglabris, fauce intus nudis, den-

tibus 1 mm. longis, subaequalibus, lanceolatis, acutis, patentibus, subrecurvis, pedicellis gracilibus 2 mm. longis; corollis rubris, 20–25 mm. longis, extus pubescentibus, tubo extra calycem multo ampliato, intus infra labiolum piloso, labro erecto, 3 mm. longo, emarginato, sinu 1 mm. profundo, labiolo breviore, lobis subaequalibus, rotundatis, medio patente; staminibus didymis, posticis vix e tubo exsertis, anticis labiolo paulo longioribus, omnibus supra tubi medium sitis, thecis divergentibus, .5–.6 mm. longis, stylo e corolla patenter exserto; nuculis non visis.

Specimens examined:

Colombia: Ayapel, *Andre K 1564* (NY) (doubtful station).

Ecuador: Provinces Azuay and Cañar, Paramo between Cuenca and Huigra, 2700–3000 m., Sept. 12–13, 1923, *Hitchcock 21693* (US); no data, *Lehmann 4676* (US); vicinity of Cañar, Sept. 15, 1918, *Rose 22720* (US).

23. **Satureia connata** nom. nov.

S. microphylla Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897; non Guss. Fl. Sic. Prodr. **2**: 120. 1828.

Gardoquia microphylla Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. **2**: 311. 1817; Benth. Lab. Gen. et Sp. 404. 1834, et in DC. Prodr. **12**: 238. 1848.

? Satureia ericoides Willd. ex Benth. in Linnaea **11**: 328. 1837.

Frutex ut videtur altitudine circa 1 m., ramis ascendentibus, teretibus, cortice discedente, ramulis quadratis pubescentibus, nodis approximatis; foliis 2–3 mm. longis, subconduplicatis, ovatis, apice obtusis, in basi cordatis, subsessilibus, margine integra, subrevoluta, pagina superiore subglabra, nitida, inferiore puberula, venis prominentioribus; floribus in axillis solitariis, bracteolis omnino foliosis, pedicellos breviter superantibus; calycibus 5 mm. longis, extus puberulis fauce intus glabris, dentibus anticis ovatis, acutis, 1 mm. longis, erectis, tribus posticis connatis, subnullis, labia itaque subintegra, pedicellis 1–1.5 mm. longis; corollis coccineis, 15–20 mm. longis, tubo extra calycem multo dilato, extus pubescente, intus infra labiolum piloso, lobo 2.5 mm. longo, emarginato, sinu 1 mm. profundo, labiolo paulo breviore, lobis subaequalibus; staminibus in hoc specimine subaequilongis, paulo supra tubi medium sitis, 1.5 mm. longis, in

tubo omnino inclusis, thecis parallelis, .5 mm. longis; stylo e corolla 1–2 mm. exserto; nuculis non visis.

Specimens examined:

ECUADOR: ranch between Ibarra and Tulcán, Carchi, 3000 m., Aug. 10–11, 1923, *Hitchcock 20793* (near type locality) (US; NY).

E. *Revolutae*

Foliis 2–6 mm. longis, ovatis vel linearibus, pagina superiore glabra, sericea vel pubescentia, inferiore tomentosa vel puberula, margine patenter saepius valde revoluta, integra; floribus solitariis in axillis (5–9 in verticillastris sat densis in *S. rigidula*); corollis 9–25 mm. longis.

This group represents the extremes of adaptation to an arid habitat to be found in the genus. The conformation of the leaves of *S. Lindeniana* is especially noteworthy.

24. **Satureia argentea** Briq. in Engler u. Prantl, Die Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia argentea Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. 2: 313. 1817; Benth. in DC. Prodr. **12**: 237. 1848.

Suffrutex procumbens, ramosus, ramis teretibus, cortice discedente, ramulis pubescentibus, quadratis, nodis approximatis; foliis 3–4 mm. longis, lanceolatis, acutiusculis, in basi rotundato-angustatis, sessilibus, margine patenter revoluta, integra, vena media subtus prominentiore, utrinque argenteo-canis; floribus in axillis solitariis, bracteolis omnino foliosis; calycibus 4.5–5 mm. longis, extus argenteo-canis, fauce intus nudis, dentibus anticis 1 mm. longis, ovatis, acutis, tribus posticis connatis, vix .5 mm. longis, acutis, pedicellis 2 mm. longis elatis, corollis coccineis, 14 mm. longis, tubo extra calycem valde dilato, extus villoso, intus infra labiolum piloso, labro erecto, 2.5 mm. longo, emarginato, sinu .5 mm. profundo, labiolo quam labro paulo breviore, lobis subaequalibus; staminibus didymis, posticis 2–3 mm. longis, vix e tubo exsertis, anticis 2–4 mm. longis, plerumque e corolla breviter exsertis, thecis paulo divergentibus, .6–.7 mm. longis; stylo e corolla 3–4 mm. exserto; nuculis non visis.

Specimens examined:

PERU: pendant from river cliff ledges, 2153 m., Llata, Aug. 21, 1922, *Macbride & Featherstone 2238* (MBG,).

25. Satureia Weberbaueri Mansfeld in Bot. Gart. Berlin-Dahlem, Notizbl. **9:** 285. 1925.

"Frutex 0.5 m. altus. Rami juniores quadrangulares, breviter puberuli. Foliorum lamina 6–11 mm. longa, 2–4 mm. lata, lamina majorum oblongo-elliptica v. lanceolato-elliptica, lamina minorum saepe linearis v. lanceolato-linearis, apice obtusiuscula, basi in petiolum angustata, margine revoluta (praecipue in foliis minoribus), supra et subtus, cano-brunneo-puberula, nervis supra immersis, subtus prominulis; petiolus 1 mm. longus vel subnullus, puberulus. Verticillastri apice ramulorum brevium spicas formantes, 2–6-flori; folia floralia conformia, calyces aequantia vel superantia; bracteae linares. Calyx 8 mm. longus, cano-brunneo-puberulus, costatus, bilabiatus (3/2), dentibus labii paullo connatis, dentibus labioli subliberis, intus puberulis. Corolla circ. 15 mm. longa, labio emarginato et labiolo trilobato circ. 3 mm. longis, extus ± pubescens, intus antice disperse pilosa. Stamina didynamia, filamenta antica 6 mm. longa, exserta, postica 4 mm. longa, subexserta; antherae divergentes. Stylus 20 mm. longus.

"Peru: Depart. Libertad, Prov. Santiago de Chuco, bei der Hacienda Angasmarca, lockeres, von Grassteppe durchsetztes Gesträuch, 3000–3100 m., ½ m. hoher Strauch mit purpurnen Blüten (Fl. 8. VII. 1914.—Weberbauer n. 7016!).

"Die nächststehenden Arten *S. argentea* (Kunth) Briq. und *S. sericea* (Presl) Briq. unterscheiden sich schon durch die dichtere, weisze Behaarung."

Mihi omnino ignota.

26. Satureia rigidula nom. nov.

S. fasciculata Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897, nec Rafin. Préc. Découv. 39. 1814; nec Tausch in Syll. Ratisb. **2:** 248. 1828.

Gardoquia fasciculata Benth. Pl. Hartweg. 243. 1839; et in DC. Prodr. **12:** 239. 1848.

Frutex altitudine 40–80 cm., ramis erectis vel ascendentibus, virgatis, ramulis numerosis, brevibus, ascendentibus, omnibus subteretibus, pubescentibus, saepe incanis, ramulorum internodiis foliis subaequilongis; foliis in axillis fasciculatis, sessilibus.

3–5 mm. longis, saepius oblongo-linearibus et in basi .5–1.5 mm. latis, frequenter tamen anguste triangulis et in basi latioribus, acutis, fere ad venam mediam revoluta, pagina superiore puberula, inferiore cano-tomentosa; verticillastris saepius 5–9-floribus, decussatim instructis, in spicam densam 1–4 cm. longam ad ramulorum apices confertis, bracteis subulatis, calycibus brevioribus; calycibus 3.5–4 mm. longis, extus puberulis, subbilabiatis, fauce intus nudis, dentibus lanceolato-subulatis, superioribus circa 1.5 mm. longis, inferioribus fere 2 mm. longis, pedicellis subnullis; corollis violaceis, circa 10 mm. longis, extus pubescentibus, tubo superne ampliato, decurvo, intus infra stamines pubescentibus, labro bifido, sinu circa .5 mm. profundo, labiolo trifido, lobo medio paulo majore, staminibus didymis, ad corollae medium sitis, anticis subexsertis, posticis inclusis, thecis divergentibus; stylo paulo exserto; nuculis oblongis, angustis, circa 1 mm. longis, fuscis.

Specimens examined:

?COLOMBIA: Rio Chota, June 6, 1876, *Andre 3583* (NY).

ECUADOR: plains of Pamasqui and San Antonio, 2615 m., *Jameson* (NY); in planitie Rumibamba necnon juxta pontem Guapalo prope Quito, *Hartweg 1338* (NY); no data, *Lehmann 6347* (US); Alausí, Chimborazo, 2500 m., July 19, 27, 1923, *Hitchcock 20719* (US); crescit in apricis prope Quito, 2461 m., Jan. 21, 1856, *Jameson 181* (GH); 1857–9, *Spruce 6062* (GH); Alausí, Chimborazo, 2500 m., July 19, 27, 1923, *Hitchcock 20705* (US).

27. **Satureia sericea** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia sericea Presl in Benth. Lab. Gen. et Sp. 402. 1834; Benth. in DC. Prodr. **12:** 238. 1848.

Suffrutex procumbens vel erectus, altitudine circa 1 m., ramis ascendentibus, teretibus, cortice discedente, ramulis quadratis, sericeo-villosis, gracilibus; foliis 5–7 mm. longis, oblongo-linearibus, 1–2 mm. latis, obtusis, in basi ad petiolum brevissimum angustatis, margine integra, valde revoluta, utrinque sericeo-villosis, argenteis, subtus albis, saepe in axillis fasciculatis; floribus tribus in axillis, rarius solitariis, brevissime pedunculatis, bracteolis primis omnino foliosis, secondariis conformalibus sed

minoribus; calycibus 6–7 mm. longis, extus sericeo-villosis, dentibus intus supra faucem pubescentibus duobus anticis 1.5 mm. longis, posticis 1 mm., omnibus lanceolatis, acutis, pedicellis 1–2 mm. longis elatis; corollis coccineis extus villosis, 22–24 mm. longis, tubo extra calycem valde dilato, intus infra labiolum piloso, labro erecto, 3 mm. longo, emarginato, sinu 1 mm. profundo, labiolo paulo breviore, lobis subaequalibus, medio tamen paulo longiore; staminibus didymis, supra tubi medium sitis, anticis 7 mm. longis, e corolla exsertis, posticis 4 mm. longis, tubo subaequalibus, antheris .7–.8 mm. longis, thecis divergentibus; stylo 6–8 mm. e corolla exserto; nuculis non visis.

Specimens examined:

Peru: sunny slopes, "Chunmis," Chasqui, 3230 m., Sept. 27, 1922, *Macbride & Featherstone 1765* (MBG; FM); grassy rocky canyon slope, 2153 m., Llata, Aug. 21, 1922, *Macbride & Featherstone 2243* (MBG; FM); hacienda, 9 mi. up river from Yanahuanca, 3282 m., northwest grassy slope, June 21, 1922, *Macbride & Featherstone 1272* (MBG; FM); no data, *Matthews* (NY).

28. **Satureia revoluta** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia revoluta Ruiz et Pavon, Syst. Veg. 149. 1798; Benth. Lab. Gen. et Sp., 405. 1834; et in DC. Prodr. **12:** 239. 1848.

S. insignis Mansfeld Bot. Gart. Berlin-Dahlem, Notizbl. **9:** 288. 1925.

Suffrutex procumbens, caulibus teretibus, cortice discedente, ramis ramulisque pubescentibus, subteretibus quadratisve, gracilibus, confertis et subfastigiatis; foliis densis, 2–3 mm. longis, ovatis vel patenter triangulis, apice obtusis, in basi truncatis, margine rarius convexa, valde et pulchre revoluta, pagina superiora viride, puberula, inferiore dense albo-tomentosa, petiolis 1 mm. longis elatis; floribus saepius solitariis in axillis, bracteolis omnino foliosis; calycibus 4.5–5 mm. longis, extus cano-puberulis, fauce intus nudis, patenter bilabiatis, labiis 1.5 mm. longis, dentibus parte dimidia breviore, lanceolatis, acutis, pedicellis maturis 3–4 mm. longis; corollis coccineis 20–22 mm. longis, tubo extra calycem multo dilato, extus molliter villoso intus infra labiolum pi-

losis, labro erecto 3 mm. longo, emarginato, sinu 1 mm. profundo, labiolo aequilongo vel paulo longiore, lobis subaequalibus; staminibus didymis supra tubi medium sitis, omnibus e tubo exsertis, anticis labro subaequilongis thecis subparallelis, .5 mm. longis; stylo e tubo 5–6 mm. exserto; nuculis non visis.

The present author has found no characters in the type collection of *S. insignis* as represented in the Field Museum to justify specific segregation from *S. revoluta* as understood by him.

Specimens examined:

PERU: *Wilkes Exp.* (US; GH); between Cuancabamba and Oyavaca, 3200 m., May 1912, *Weberbauer 6333*, (FM, *type collection* of *S. insignis* Mansf.); Oroya near Lima, 1919, *M. Kalenborn 162* (US; MBG); ? Culluy, July, *Matthews 666* (GH).

29. **Satureia Lindeniana** Briq. in Ann. Conserv. et Jard. Bot. Genève 2: 191. 1898.

Suffrutex ut videtur, altitudine circa 15 cm., ramis e caudice lignoso erectis, virgatis, subteretibus, pubescentibus, nodis inter se 2–5 mm. distantibus, ramulis brevibus, erecto-ascendentibus; foliis circa 4 mm. longis, erectis, sessilibus, oblongo-linearibus, apice obtusis, in basi rotundato-angustatis, marginibus integris, valde replicatis et infra venam mediam conniventibus, paginam inferiorem cano-tomentosam itaque toto adumbrantibus, facie superiore pubescente, inferiore glabra; floribus oppositis, solitariis in axillis, calycibus subtubulosis, 6 mm. longis, extus puberulis, paulo arcuatis, patente bilabiatis, labia superiore 2 mm. longa, dentibus ad medium connatis, breviter triangulari-lanceolatis, inferiore 3 mm. longa, dentibus lanceolato-subulatis inter se liberis et a labia superiore sinu distinctiore separatis, pedicellis 1 mm. longis elatis; corollis 9 mm. longis, extus pubescentibus, tubo intus nudo, superne ampliato, leviter arcuato, labro suberecto, 1 mm. longo, ovato, emarginato, labiolo 2 mm. longo, patente, lobo medio majore obovato; staminibus sub labro ascendentibus; stylo paulo exserto; nuculis non visis.

Specimens examined:

COLOMBIA: Nevada Sta. Marta, *Purdie* (GH).

30. **Satureia rugosa** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Gardoquia rugosa Benth. Lab. Gen. et. Sp., 399. 1834; et in DC. Prodr. **12**: 236. 1848.

"fruticosa, villosa, foliis petiolatis ovato-rhomboideis serrato-dentatis basi rotundatis coriaceis rugosis utrinque villosis subtus vix canescentibus, verticillastris laxis, multifloris, calycis villosi dentibus subulatis ciliatis, fauce intus subnuda, corollis calyce vix duplo longioribus. In Peruvia (Ruiz et Pavon!). Frutex ramosissimus, ramis duris tetragonis junioribus rufo-villosis. Folia 1–1½ pollicaria, reticulato-venosa, floralia minora et cymas superantia. Cymae breviter pedunculatae. Bracteae oblongae, villosae, calyce breviores. Pedicelli breves. Calyces 3 lin. longi, tenues, virides, villosissimi. Corolla villosa, labio superiore erecto, brevissime emarginato, inferiore subpatente, lobis oblongis inter se subaequalibus obtusis integerrimis. Stamina didynama, antheris sub labio superiore per paria approximatis. Species aequo jure ad Melissam, Micromeriam, vel Gardoquiam referenda (v.s. olim in herb. Lamb.)." (Benth. in DC. Prodr. **12**: 236. 1848).

Sect. *Xenopoma* (Willd.) Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Xenopoma Willd. in Ges. Naturforsch. Fr. Berlin Mag. **5**: 399. 1811.

Suffrutices fruticulive, rarius herbae perennes humiles, ramulis divaricatis, foliis obovatis, subintegris, pubescentibus; floribus 1–6 in foliorum axillis, praecipue in speciebus humilibus solitariis, pedicellis quam calycibus brevioribus, singulis bracteolis duobus ornatis elatis; calycibus tubulosis, frequenter subturbinatis, dentibus subaequalibus obscure bilabiatis acutis, intus nudis vel hirsutis, erectis vel patentibus; corollae tubo omnino incluso vel breviter exserto.

31. Satureia nubigena Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Thymus nubigenus Kunth in Humboldt et Bonpland, Nov. Gen. et Sp. Pl. **2**: 316. 1817.

Micromeria nubigena Benth. Lab. Gen. et Sp. 381. 1834; et in DC. Prodr. **12**: 222. 1848.

Thymus humifusus Willd. ex Benth. in Linnaea **11**: 342. 1837.

Herba procumbens, fragrans, caulibus reptantibus, ramosissimis, ramis ramulisque filiformis, atris, puberulis hispidisve, subteretibus, foliis 3–4 mm. longis, approximatis, plerumque ovatis, apice obtusis, in basi ad petiolum angustatis, frequenter rotundato-ovatis et in basi sub-truncatis, utrinque puberulis saepius villosulis vel hispidulis rarius subglabris, margine integra revoluta; floribus in axillis solitariis, bracteolis parvis, linearibus, parte tertia pedicellorum longis ornatis; calycibus 3–4 mm. longis, superne patenter dilatis, hirsutulis, sub-15-venis, fauce subnudis, dentibus .6–.9 mm. longis, lanceolato-acuminatis, aequilongis, anticis tamen patenter majoribus quam posticis tribus, pedicellis 1.5–2 mm. longis elatis; corollis 5–6 mm. longis, tubo superne sat ampliato, nectarostegio e pilis intus fauce areolam formante, labro emarginato, sinu parte dimidia labri longitudinis profundo, labioli lobo medio majore, rotundato, 1–1.5 mm. longo; staminibus parvis, circa 1 mm. longis, didymis, supra tubi medium sitis, thecis paulo divergentibus; stylo corolla aequilongo; nuculis .8–.9 mm. longis, oblongis, atris.

Specimens examined:

VENEZUELA: "Poleo de paramo," Paramo Sto. Domingo, 3600 m., Mérida, Sept. 14, 1922, *Jahn 1151* (US); Laguna Verde, Paramo Mucuchies, Mérida, 3384 m., 1922, *de Bellard 19* (US); summit of Páramo, Quirorá, 3200 m., Mérida, Feb. 24, 1922, *Jahn 882* (US); Sierra de Nevada de Mérida, Laguna del Gallo, 4070 m., Dec. 1910, *Jahn 74* (US).

COLOMBIA: in monte ignivomo Azufral, May 18, 1876, *Andre 3249* (NY); Hacienda de Antisana, *Hartweg 1337* (NY); Ruiz, 3000 m., 1918, *Dawe 750* (NY); Canaan, Mt. Puracè, El Cauca, open near Rio Anambiu, 2900–3200 m., June 11–16, 1922, *Killip 6732* (ASP; US); dry open, 3500–4000 m., Paramo de Ruiz, Tolima, Dec. 16–17, 1917, *Pennell 3015* (US; MBG; GH; NY); Westabhange des Paramó de Ruiz, El Cauca, 3000–3500 m., Sept. 11, 1883, *Lehmann 3111* (US).

ECUADOR: Andes near Quito, 4000 m., *Couthouy* (NY); Andes of Quito, 4000 m., *Jameson 217*, "crescit in graminosis alpinis (vernacule "paramo de los Andes"), 4000 m., Jan. 21, 1856 (US; GH); Paramo de Tuza, 3400 m., Jan. 31, 1881, *Lehmann 3092 a* (US); between Urbina and Mt. Chimborazo, 3600–4500 m., Prov.

Chimborazo, Oct. 4, 1923, *Hitchcock 21987* (US; NY); La Rinconada between Ibarra and Tulcan, 3000 m., Carchi, Aug. 10–11, 1923, *Hitchcock 20787* (US; NY); paramo between Oña and Cuenca, 2700–3300 m., Azuay, Sept. 9–10, 1923, *Hitchcock 21635* (US).

Peru: mountain of ? Pellshum, "very plentiful," *Jameson* (ASP); on mossy rock, Tambo de Vaca, 4000 m., June 10–24, 1923, *Macbride 4399* (FM; MBG).

Var. **glabrescens** Benth in DC. Prodr. **12:** 222. 1848.

Ramis foliisque puberulis vel subglabris nec villosulis hispidulisve.

Specimens examined:

Colombia: dry grassy paramo, 3700–4200 m., Paramo del Quindio, Caldas, Aug. 15–20, 1922, *Pennell & Hazen 10001* (US; ASP); grassy paramo, "Llano de Paletara," 2950–3100 m., June 15–17, 1922, *Pennell 6930* (ASP; US); no data, *Lehmann 4719* (US); Popayan, in paramo de Guanacas, *Hartweg 1336* (NY).

Ecuador: Quitensian Andes, 1855, *Couthouy* (GH).

Peru: 6 mi. south of Mito, 3076 m., Aug. 1–5, 1922, *Macbride & Featherstone 1821* (NY; MBG).

32. **Satureia Darwinii** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Micromeria Darwinii Benth. in DC. Prodr. **12:** 222. 1848.

Fruticulus humilis, prostratus, tegetes faciens, caulibus in basi lignosis, ramis numerosis, subteretibus, pubescentibus, internodiis maximam partem minus quam foliorum longitudine; foliis 4–5 mm. longis, obovatis vel subspatulatis, obtusis, in basi angustatis, paginis ambobus pubescentibus; floribus in axillis solitariis, pedicellis circa 1 mm. longis, bracteolis duobus supra medium positis; calycibus vix 4 mm. longis, 15-venis, extus pubescentibus, dentibus 1 mm. longis, ovato-lanceolatis, obtusis, subaequalibus, incurvis, intus hirsutis, corollis 5 mm. longis, tubo incluso, labro bifido, labioli lobo medio majore; staminibus inclusis, vix 1 mm. longis, thecis sub-parallelis; nuculis von visis.

Specimens examined:

Argentina: S. Patagonia in patches everywhere, Nov. 15, 1896, *Peterson* (NY); Patagonia, 50/30, 1882, *Moreno 186* (NY); Killikaike, Patagonia, *Brown 65* (NY).

33. **Satureia pusilla** Macl. in Rept. Princeton Univ. Exp. to Patagonia 8: 698. 1905.

Micromeria pasilla (sic) Phil. Anal. Univ. Chile 90: 556. 1895.

Herba perennis humilis, altitudine 5–6 cm., caulibus in basi duris, repentibus, ramis numerosis, gracilibus, puberulis, subteretibus; foliis 3–4 mm. longis, obovatis, in basi angustatis, utrinque puberulis, subsessilibus; floribus in axillis solitariis, pedicellis circa 2 mm. longis, bracteolis duobus ad medium positis; calycibus 3.5 mm. longis, extus hispidissimis, setis patentibus, 13-venis, bilabiatis, dentibus tribus posticis circa .4 mm. longis, anticis circa .6 mm., omnibus ovato-triangulis, acutis, saepe purpurascentibus, intus hirsutis, margine ciliolata; corollis vix 5 mm. longis, labro bifido, labiolo longiore, lobo medio majore; staminibus inclusis, vix 1 mm. longis, thecis parallelis; nuculis non visis.

Specimens examined:

ARGENTINA: Gregory Bay, Magellan Sts., Nov. 23, 1886, *Safford* (NY, *type collection*).

34. **Satureia vana** sp. nov.

Frutex foliosus altitudine 2 m., ramis teretibus, ramulis divaricatis, quadratis, puberulis, internodiis folia subaequantibus, foliis 8–12 mm. longis, late ovatis vel subrotundatis, obtusis, in basi saepius cuneatis, rugosis, margine supra medium subserratis, paginis ambobus puberulis, petiolis circa 1 mm. longis; floribus 3–6 in foliorum axillis, verticillastris subsessilibus, bracteolis 1 mm. longis ornatis; calycibus 3.5 mm. longis, in basi leniter angustatis, 13-venis, extus praecipue ad venas hispidulis, dentibus circa 1 mm. longis, ovatis, acutis, subaequalibus sed duobus anticis tamen longioribus, intus tenuiter hirsutis, pedicellis subnullis; corollis 7–8 mm. longis, extus villosulis, tubo superne gradatim dilato, labro 1.5 mm. longo, bifido, labiolo paulo longiore, lobo medio majore; staminibus didymis, breviter exsertis, thecis divaricatis; nuculis non visis.

A nondescript species singularly devoid of any marked character, but combining characteristics of sections *Gardoquia* and *Xenopoma*.

Specimens examined:

Peru: rainy-green formation, 3100 m., Carumas, Moquegua, Feb. 21–March 6, 1925, *Weberbauer 7259* (FM, type).

35. **Satureia boliviana** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Micromeria boliviana Benth. Lab. Gen. et Sp., 731. 1835; et in DC. Prodr. **12:** 222. 1848.

Xenopoma bolivianum Griseb. in Goett. Abh. **25:** 272. 1879.

Satureia Kuntzeana Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Frutex ramosus altitudine 30–90 cm., caulibus teretibus glabris, cortice discedente, ramis ramulisque puberulis, gracilibus, quadratis, angulis acutis, submarginatis; foliis .5–1.5 cm. longis, magnitudine formaque diversis, eis in ramulis sterilibus diffusis, ovato-ellipticis, obtusis vel subacutis, in basi cuneato-angustatis, margine frequenter obscure serrata et revoluta, plerumque 1–1.5 cm. longis, eis in ramulis florentibus densis saepius oblongis, obtusis, in basi angustatis, margine integra et revoluta, plerumque .5–1 cm. longis, omnibus utrinque puberulis floribus solitariis in axillis, subsessilibus et in paniculis brevibus lateralibus dispositis (frequenter tamen in ramis substerilibus tribus in axillis pedunculo breve elatis);calycibus 3 mm. longis, tubulosis, dentibus lanceolatis-acutis, subaequalibus, corollis 8–9 mm. longis, pubescentibus, tubo superne patenter ampliato, intus ad medium breviter piloso, labro 1 mm. longo, emarginato, labiolo 2 mm. longo, lobis subaequalibus, rotundatis, medio paulo majore; staminibus didymis 2–2.5 mm. longis, supra tubi medium insertis, thecis paulo divergentibus; stylo corolla aequilongo; nuculis non visis.

Satureia Kuntzeana was based by Briquet on a collection by Kuntze at Tunari, 4000 m., Apr. 1892. It was referred by him to the Section *Gardoquia* to a position near *S. microphylla* (*S. connata* nom. nov.) and *S. Jamesoni* with the following note "Les corolles sont blanches au lieu d'être écarlates, c'est encore une exception qui fortifie notre conception des *Gardoquia* comme simple section du genre *Satureia*." A sheet at the U. S. Nat. Herb. bearing the above-cited collection-data and labelled in Kuntze's hand "*Satureja Kuntzeana* Briq.," is assuredly *S.*

boliviana. It corresponds in every way to Briquet's description of the type.

Specimens examined:

BOLIVIA: Cotani, 2450 m., Sept. 1911, *Buchtien 5878* (US); La Paz, 2653 m., Aug. 15, 1901, *Williams 1674* (US; NY); Larecaja, Sorata, 2650–3300 m., Feb. 1857–July, 1858, *Mandon 517* (GH; NY); an sonnigen Abhängen, 3600 m., La Paz, Sept. 3, 1906, *Buchtien 438* (US); Tiahuanaco, 3900 m., Nov. 1913, *Buchtien 438* (GH; NY); La Paz, sonnige Abhänge, 3700 m., Nov. 3, 1906, *Buchtien* (GH); vic. of La Paz, Aug. 15, 1914, *Rose 18894* (US; NY); no data, *Bang* (NY); viciniis Achacache, monticula Arichaca in petrosis, 4000 m. alpine, Jan. 1859, *Mandon 518* (apparently a dwarf from 15 to 20 cm. tall, otherwise about the same) (NY); Tunari, 4000 m., Apr. 5, 1892, *Kuntze* (*type collection* of *S. Kuntzeana* Briq.) (US); Sirupaya bei Yanacachi, 2100 m., Nov. 28, 1906, *Buchtien 315* (US); Unduavi, 3076 m., Oct. 1885, *Rusby 1500* (ASP; US; GH; NY).

Var. **tarijense** comb. nov.

Xenopoma bolivianum Griseb. var. *tarijense* Wedd. in Griseb. Symb. Fl. Argent. 272. 1879.

Foliis patenter serratis, crenarum culminibus acutis, inter se 1–2 mm. distantibus, pagina inferiore pallidiore; corollae tubo calyce duplo longiore.

Specimens examined:

ARGENTINA: Cuesta de Tesanca et del Inca, May 25, 1873, *Lorentz & Hieronymus 1037* (NY).

36. Satureia simulans sp. nov.

Frutex ramosus foliosusque altitudine circa 2 m., ramis teretibus vel subquadratis, cortice discedente, ramulis ascendentibus, pubescentibus, quadratis, angulis obtusis; foliis 1–2 cm. longis, lanceolatis, acutis, in basi rotundato-cuneatis, utrinque breviter pubescentibus, margine revoluta, subserrata, petiolis 1–2 mm. longis elatis, floribus 3–6 in axillis, pedunculis brevibus elatis, rarius in axillis superioribus solitariis, bracteolis circa 1 mm. longis ornatis; calycibus 3.5 mm. longis, extus hirsutis, fauce intus nudis, dentibus fere 1 mm. longis, lanceolatis, acutioribus, duobus anticis quam posticis tribus paulo longioribus et saepe patentibus,

pedicellis subnullis; corollis 6–8 mm. longis, tubo intus piloso, superne gradatim dilato, labiis 1.5–2 mm. longis, labro emarginato, sinu .5 mm. profundo, labioli lobis subaequalibus, rotundatis, medio ad basim angustato; staminibus didymis, supra tubi medium sitis, vix e tubo exsertis, thecis parallelis, .4 mm. longis; stylo e tubo paulo exserto; nuculis von visis.

Planta aspectu *S. boliviana* speciminibus substerilibus valde similis, floribus tamen differt.

Specimens examined:

Bolivia: Unduavi; Nord Yungas, 3300 m., Nov. 1910, *Buchtien 2954* (US); Unduavi, shrub 2 m., 3300 m., Nov. 1910, *Buchtien 2955* (US, type); Sorata, Apr. 19, 1920, *Holway 550* (US).

37. **Satureia axillaris** (Rusby), comb. nov.

Bystropogon axillare Rusby, Mem. Torr. Bot. Club 6: 108. 1896.

B. uniflorus Busby in Briq. Bull. l'Herb. Boiss. 4: 802. 1896.

Suffrutex diffusus, ramosus, altitudine ad 1 m., caulibus ramis ramulisque gracillimis, glabris, quadratis vel caulibus teretibus, angulis submarginatis; foliis 10–25 mm. longis, 1.5–3.5 mm. latis, lineari-lanceolatis, rarius oblongis, apice acutiusculis, in basi ad petiolum brevem vel subnullum angustatis, utrinque omnino, glabris, margine subrevoluta, obscurissime et sparse serrata; floribus in axillis solitariis, bracteolis parvis, subulatis, quam pedicellis brevioribus subtentis; calycibus 1.5–2 mm. longis, tubulosis, dentibus lanceolatis, acutis, patentibus, subaequalibus, fauce intus glabris; corollis calyces vix superantibus, 2.5 mm. longis, tubo superne ampliato, intus glabro, labro emarginato, labioli lobo medio patente, rotundato, 1 mm. longo, staminibus minutissimis ad tubi medium sitis; stylo corolla aequilongo; nuculis non visis.

Specimens examined:

Bolivia: Bolivian plateau, 1891, *Bang 1125* (*type* of *Bystropogon axillare* Rusby) (US; ASP; MBG; GH); Sierra de Santa Cruz, 1600 m., May, 1892, *Kuntze* (NY).

38. **Satureia brevicalyx** sp. nov.

Suffrutex erectus altitudine 50–60 cm., caule ut videtur virgato, puberulo, quadrato, angulis obtusis, internodiis 2–4 cm. longis,

ramulis numerosis brevibus, ascendentibus, gracilibus, puberulis; internodiis 3–10 mm. longis; foliis 3–5 mm. longis, ellipticis vel ovalibus apice saepius obtusis, in basi rotundato-angustatis, margine revoluta, subintegra, utrinque molliter hirtellis, petiolis circa 1 mm. longis elatis; floribus solitariis in axillis, numerosis, bracteis subulatis, quam pedicello brevioribus subtentis; calycibus 3 mm. longis, late tubulosis, subbilabiatis, fauce intus nudis, dentibus ovatis, obtusis, subaequilongis; corollis 5–6 mm. longis, extus pubescentibus, tubo leniter arcuato, superne ampliato, intus infra stamines hirtello, labro subrecto, ovato, emarginato, labiolo quam labro paulo longiore, lobo medio obovato, majore; staminibus 1 mm. longis, inclusis, thecis parallelis, supra tubi medium sitis; stylo paulo exserto; nuculis ovatis, fuscis, .5 mm. longis.

Specimens examined:

PERU: Panticalla Pass, 3600 m., July 16, 1915, *Cook & Gilbert 1877* (US); "Bolivian and Peruvian Andes" (GH); Cuzco, March, 1925, *Herrara 825* (US, TYPE).

39. **Satureia oligantha** Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 380. 1897.

Micromeria Gilliesii Benth. Lab. Gen. et Sp. 381. 1834; et in DC. Prodr. **12**: 222. 1848.

Xenopoma eugenioides Griseb. in Goett. Abh. **19**: 237. 1874.

Micromeria eugenioides Hieronym. in Acad. Nac. Cordoba, Bol. **4**: 413. 1881.

?*Bystropogon minutus* Briq. in Bull. l'Herb. Boiss. **4**: 803. 1896.

Satureia Gilliesii Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897 (sub Sect. *Xenopoma*).

S. eugenioides Loes. ex Robt. Fries in Nov. Acta Soc. Upsal. IV. **1**: 107. 1905.

Suffrutex ramosus altitudine circa .5 m., in basi lignosus, caule terete, cortice discedente, ramis ramulisque puberulis vel tenuiter pubescentibus, gracilibus, subtortis, quadratis, angulis acutis; foliis 3–8 mm. longis, approximatis, oblongis, obtusis, utrinque puberulis vel pubescentibus, glandulosis, margine subrevoluta; pedicellis .5–1 mm. longis, subsolitariis, tribus tamen frequenter

in axillis inferioribus pedunculo breve elatis, bracteolis subulatis, pedicellis aequilongis ornatis; calycibus parvis, 1.5–2 mm. longis, campanulatis, dentibus subaequalibus, acuminatis, patentibus et paulo recurvis, fauce intus subvillosis; corollis calyces vix superantibus, 2.5 mm. longis, tubo superne ampliato, intus glabro, labro emarginato, labioli lobo medio patente, rotundato, 1 mm. longo, staminibus minutissimis ad tubi medium sitis; stylo corolla aequilongo; nuculis oblongis, .7 mm. longis.

Specimens examined:

Peru: above Chivay, Coilloma, Arequipa, March, 1914, *Weberbauer 6891* (FM).

Bolivia: Oruro, Tapacari, 4000 m., March 17, 1892, *Kuntze* (*type collection* of *Bystropogon minutus*) Briq. (NY).

Argentina: Sierra Farmatura, 1873, *Lorentz & Hieronymus* (NY); Cuesta de la Muschaca, Catamarca, Feb. 1876, *Schickendanz 254* (NY); Sierra de Tucuman, Jan. 10–17, 1878, *Lorentz & Hieronymus 722* (US); Capillitas, Catamarca, 1875, *collector unknown* (ASP); El Candado, Andalgalá, Oct. 2, 1916, *Jörgensen 1139* (MBG; UC).

Species Mihi Omnino Ignotae

Micromeria pulchella Wedd. Chlor. And. **2**: 151. 1857.

Gardoquia salviaefolia Colla Mem. Accad. Torin. **39**: 2. 1836.

Satureia bonariensis Briq. in Engler u. Prantl, Nat. Pflanzenfam., ed. 1, IV. Abt. 3a, 300. 1897.

Micromeria bonariensis Fisch. et Mey. Ind. Sem. Hort. Petrop. **10**: 56. 1845.

"hispidula, caulibus erectiusculis, foliis linearibus punctato-glandulosis integerrimis, verticillastris sexfloris, corollis inclusis. In Bonaria unde sem. misit Bonpl. Thymus Bonariensis Ten. Ind. Sem. Hort. Neap. 1839. Corolla in planta culta saepissime calyptraeformis, non expansa, ex Fisch. Mey. An revera didynama? An eadem ac Hedeoma multiflora?" (Benth. in DC. Prodr. **12**: 223. 1848.)

Index Specierum

New species, varieties, and combinations are printed in **bold face type**; synonyms, in *italics;* and previously published valid names in ordinary type.

Annals
of the
Missouri Botanical Garden

Vol. 14 APRIL, 1927 No. 2

A MONOGRAPH OF THE GENUS PHOLIOTA IN THE UNITED STATES

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I. Aims and Methods

Several years of study of the higher Basidiomycetes have brought to the writer the conviction that until very recently mycologists have overlooked many of the important details in the structure of these plants. No genera are more significant in this respect than *Corticium*, *Peniophora* and *Hymenochaete* of the *Thelephoraceae; Flammula*, *Hypholoma* and *Pholiota* of the *Agaricaceae;* and *Lycoperdon* and *Bovista* in the *Lycoperdaceae*. In these and in many other (perhaps nearly all) genera the microscope reveals contrasting details of structure that were entirely unknown to the earlier generations of mycologists. These details have been so much neglected that it may be truthfully said that the current conception of species in fungi has lagged considerably behind that of seed plants. Many of the so-called species in our mycological literature have been in reality species complexes. While it must be admitted that specific limitations must always be to some extent a matter of individual opinion, yet undoubtedly taxonomists will more nearly agree in these opinions when the details of structure become a part of the current knowledge about these plants. The facts concerning them should be set in orderly array, open to the inspection and criticism of all. Descriptions alone will not so present them. Much may be said against

running each description, as it were, into a mold or through a mill, hewing them all down to the same thickness and cutting them all off to equal length; yet after all it is the only way to make the plants stand in contrast to each other. How often one comes upon a descriptive item that he suspects may be of prime importance, only to find, when seeking a contrast with another species, that no mention is made of the presence or absence of this characteristic. Single points of difference do not usually make a species, to be sure; therefore, all the more reason for available diagnoses that will enable one to contrast two or more species on all points. It is the aim of this paper to so contrast in particular the microscopic details within one genus of the Basidiomycetes.

The paper is the outgrowth of a critical study of the species of the genus *Pholiota* of the *Agaricaceae* for the 'North American Flora.' The drawings illustrating the microscopic details are all made to the same scale in the different species so that direct comparisons can be made. All were outlined under the camera lucida from free-hand transverse sections of the gills of dried plants after softening with alcohol and water, mounting in KOH, and staining with dilute eosin. The larger drawings of the spores were made in the same way except under the oil-immersion lens, yielding a magnification of about 1800 diameters. The spore measurements represent normal variations of what are believed to be mature spores, a series of usually not less than 10 spores being measured for each species.

II. Historical

Only very recently has this genus received critical study at the hands of American mycologists. In 1908 Peck published[1] one of his latest and best monographs, dealing with this genus in the state of New York. It was followed in 1912 by the work of E. T. Harper[2] on the species occurring in the region of the Great Lakes and to which additions were made in two subsequent papers.[3] The illustrations published by him constitute the finest

[1] Bull. N. Y. State Mus. 122: 141–158. 1908.
[2] Trans. Wis. Acad. Sci. 17: 470–502. 1912.
[3] *l. c.* 17: 1011–1014. 1913; 18: 392–405. 1916.

work of the kind that has appeared in America. Yet his descriptions were in many cases inadequate, though possessing the advantage that many of them were drawn from the plants as he found them growing in nature. Yet many were only quotations from the earlier work of Peck. His most important contribution, aside from the illustrations, was the fact, presented for the first time, that the species may be grouped into phylogenetic units with rather well-marked characteristics for each group, the species within these units differing in lesser degree. The importance of this grouping cannot be ignored yet can be over-emphasized to the confusion of one not well acquainted with the genus. Without access to material of authentic European species he was forced to rely on published descriptions, and to some extent he was misled by erroneous identifications by others. In 1918 appeared Kauffman's work[1] on the gill fungi of Michigan in which the species were well described but inadequately illustrated.

The contribution that I have attempted to make in the present paper has been largely in the matter of the details of microscopic structure of the hymenium. It is a matter of constant surprise to see how easily species may be separated by this means; and by a combination of microscopic and macroscopic characters most of the species take their place with a definiteness that is remarkable. Even where macroscopic features are in themselves characteristic enough to delimit species it is reassuring to be able to confirm a determination by a set of facts deduced from an entirely different source.

While this sort of work cannot be said to be a new angle of attack for taxonomic work in the higher Basidiomycetes, yet instances where it has been systematically used in the gill fungi are remarkably scarce and no instance has come to my attention where the microscopic characters have been enumerated and illustrated to a sufficient extent in a single genus of that group. The nearest approach to this has been in the work of Lange on the Agarics of Denmark.[2] However, the illustrations there are

[1] The Agaricaceae of Michigan. Mich. Geol. & Biol. Surv. Publ. 26: 1–899. 1918.

[2] Lange, J. E. Studies in the Agarics of Denmark. I. The genus Mycena. (Dansk Bot. Arkiv 1^5: 1–40. 1914); II. Amanita. Lepiota. Coprinus. (*l.c.* 2^3: 1–53. 1915); III. Pluteus. Collybia. Inocybe. (*l. c.* 2^7: 1–50. 1917); IV. Pholiota. Marasmius. Rhodophyllus. (*l.c.* 2^{11}: 1–46. 1921.)

woefully inadequate on this point so that the entire effect is not much better than the rather complete descriptions of microscopic characters presented by Kauffman.

III. Preparation of the Keys

In preparing the key to species I have been at some loss to know on what points to make the larger divisions. A number of possibilities present themselves for consideration. Previous writers have for the most part attempted to follow the scheme outlined by Fries, making the first division on the basis of habitat. I have attempted to use the point of comparative sizes instead. In any scheme there will always be some overlapping. At first thought it might appear that in using habitat there can be no overlapping, for either the plants grow on wood or else they grow on the ground. Yet in reality the matter is not so simple. Some species grow on earth heavily charged with humus or very rotten wood; some grow from buried wood, and in either case, unless great care is exercised at all times in the field, the collector will be at a loss to know how to refer his habitat or if unobservant will name it wrongly. The weak point about most keys lies in the failure to take into consideration these overlapping forms, and when that is properly cared for the exact point on which the division is made becomes of secondary moment, unless, of course, one is interested in showing phylogenetic relationships in the key. But phylogeny assumes or demonstrates similarities, and the purpose of a key is to show contrasting differences. It is impossible, therefore, to combine these opposing views in one key with any high degree of satisfaction.

IV. Microscopic Observations

Both in the keys and in the descriptive matter I have laid considerable emphasis on the cystidia and the spores. The cystidia in this genus fall for the most part into three general categories. These are represented as follows: (1) Text figures 1, 3, 5, 9, 15, etc., in which they are enlarged and quite conspicuous, varying from almost round to fusoid. This type might in fact be broken into two types, one that does not present a narrowed apex and one that does. Yet they intergrade to a considerable extent. (2) Text

figures 40, 43, 46, 83, 87, etc., in which the buried base is enlarged into a bulb, and the apex, that may be long and cylindrical, projects prominently beyond the basidia. (3) Text figures 127, 129, 131, 135, 137, 139, etc., in which they are brown in color, particularly in dried plants, and do not usually project prominently, sometimes not at all. It has not been deemed expedient to illustrate the fact that these last bodies are colored except in figs. 127, 129, and 135, where they have been darkened slightly. At least in the key, measurements in diameter of all of these bodies are measurements through the broadest part, which is usually imbedded between the basidia. In the matter of spore sizes rather narrow distinctions have been drawn in the keys at times, and careful measurements of several representative spores should be made before conclusions are reached. In general, the smallest spores, except in cases where spore prints have been obtained, should be disregarded, especially if they appear somewhat lighter in color, since such are obviously immature. Spore markings, if present, can usually be detected with the ordinary high power of the microscope, especially if a 10 × or a 12 × ocular be employed. In such cases, definite indications of roughness on the part of *some* spores indicate that they should be classed as rough-walled. An oil-immersion lens is a convenience in substantiating roughness where dry-lens examination is not conclusive. Emphasis has also been laid on the appearance of a slight degree of truncateness on one end of the spore in some cases (figs. 2, 8, 14, 95, etc.). This is usually an obscure point at first, but once detected it can be rather readily recognized under the high-power dry lens. That this truncateness is in reality on the apex of the spore and does not represent its point of attachment to the sterigma, as would at first appear, has been repeatedly verified.

V. Nomenclature and Synonymy

In the matter of nomenclature and synonymy I have used, for all my plants, names that have been current in the present generation of mycologists, without attempting in any case to replace well-established names with those of an earlier and often a doubtful designation. I have, however, not hesitated to use current European names in place of names of an American origin when

I have been able to satisfy myself of their equivalence. I consider the genus to have been established to all intents and purposes by Fries in the 'Systema Mycologicum' in 1821. For the rest I have followed the International Code in the matter of citations.

VI. Phylogenetic Considerations

As has been mentioned on a preceding page, the species of *Pholiota* fall into several rather well-marked phylogenetic units, each with a central species around which the others may be grouped. It may or may not be possible to select the central species which would represent the ancestral types of the group in each case, and the evolutionary development within a group may not have taken place symmetrically but may have been all in one general direction, but the fact remains that the species within any one of these groups are more closely related to each other than they are to the members of any other group. The recognition of these groups is a relatively easy matter, since in most cases they do not intergrade. On the other hand, the boundaries of the more recently recognized types within these groups are often quite a difficult matter, since they are not always sharply delimited. In the matter of marking out these more elementary species, individual opinion must always play an important part, and for that reason different investigators may not always come to the same conclusion.

Since in the presentation that constitutes the bulk of this article attention is directed to only the fundamental taxonomic features, I shall here briefly consider these phylogenetic units within the genus. Relationships are expressed in similarities in what are believed to be the more significant and deep-seated characters, and those that are less likely to vary under varying external conditions. Two of the most important of these are the spores and the cystidia. For example, the peculiar truncate spore and the large cystidia, all of the same type and different from almost all others in the genus, are to me a mark of relationship between *P. dura*, *P. praecox*, *P. vermiflua*, *P. temnophylla*, *P. Howeana*, and *P. Acericola*. It so happens that these species agree also, at least in a general way, in several other characters, e.g.,

general form and coloration, habitat, absence of all scaliness, etc. In the same way there is a small group centering around *P. erebia* that shows close agreement in spore characters and in the characteristic cystidia with long projecting necks. Here again, other points, less easy to express quantitatively, leave no doubt that we are dealing with a group of closely related species, and far more closely related among themselves than to individuals of any other group. But only about 80 per cent of the species here treated show similarities by which they can be so grouped at present. The remainder must be carried as unattached species, perhaps in some cases representing a non-plastic or stabilized condition, at least temporarily. Some of the forms that I have left unattached were given more definite placings by Harper, to which I cannot subscribe. These exceptions have been noted in the tabulation that follows. Harper recognized twenty such groups or phylogenetic units, several of them monotypic and several not designated by name. After the first dozen have been marked out the remainder are found to be more problematic. My own interpretation of the situation at present follows.

In the first place, authors since the time of Fries have rather consistently recognized two large divisions of the genus on the basis of habitat. These are the sections that have been designated as the *Humigeni* and the *Truncigeni*, since their members occur on the ground and on wood, respectively. Two or three species are limited to a muscigenous habitat and have been designated as the *Muscigeni*. Within these large divisions the phylogenetic units appear as follows:

SECTION I. HUMIGENI

1. The Praecox Group.[1]—With prominent broad cystidia and spores truncate at the apex. General color ochraceous or paler. No scales on pileus.

P. praecox, P. vermiflua, P. Howeana, P. temnophylla, P. Acericola (also *P. dura* of Europe).

While *P. Acericola* frequently grows on rotten wood and perhaps

[1] Items are to be taken as characteristic of the groups in which they are mentioned. Therefore in using this synopsis as a key the plant is to be placed in that group with which its characters best agree regardless of whether or not these are stated as contrasting characters for the groups.

never on the bare ground, all of its other characters ally it with this unit. Harper puts *P. Howeana* into a separate section with *P. ventricosa* (= *P. spectabilis*), to which I cannot subscribe.

2. The Togularis Group.—Without cystidia. Spores truncate (except in *P. blattaria*, at times). Ochraceous or paler in color, and small in stature, with a median membranous annulus striate on the upper surface.

P. togularis, P. blattaria, P. rugosa, P. filaris.

Harper includes *P. anomala* in this group. I have included it among the unattached species.

3. The Erebia Group.—Spores elongate-elliptic, 10–15 μ long, not truncate. Cystidia abundant, flask-shaped with long necks.

P. erebia, P. ombrophila, P. subnigra, P. platyphylla.

4. The Caperata Group.—Spores rough. Cystidia none. Pileus orange-cinnamon or ochraceous-orange. Plants of rather large stature.

P. caperata, P. Mcmurphyi.

Harper includes *P. Johnsoniana* here, but its characters make it quite distinct in my opinion.

5. The Terrestris Group.—Spores smooth, less than 10 μ long. Cystidia rather indefinite but some sterile bodies present and recognizable. Pileus scaly with small scales.

P. terrestris, P. angustipes.

This group may not be a natural one but does show some transition over towards the *Truncigeni*. While not known to grow on wood, the latter species grows around stumps and is likely attached to buried wood. *P. terrestris* may eventually show such an attachment, and both species bear in the hymenium a very simple and inconspicuous type of sterile body that resembles to a degree those of the *Adiposa* section of the *Truncigeni*. However, the group is advanced with some misgivings. *P. albivelata* could be forced into the same alliance were it not for the entirely glabrous and viscid pileus. If it were admitted, *P. anomala* might be included also. *P. trachyspora* would be included were it not for its rough spores.

Unattached Species of the Humigeni.—(1) *P. albivelata*. A rather

anomalous species that might stand as the type of a distinct group. (2) *P. anomala.* Too indefinite to place and may prove to be referable to an older species. My study of the types would deny its inclusion in the *Togularis* group as referred by Harper. (3) *P. aurea* is difficult to interpret. It may grow attached to buried wood and belong in the *Truncigeni* as would be indicated by its color. (4) *P. duroides* and *P. Johnsoniana* might be regarded as constituting a distinct group near the *Praecox* group but neither would seem to belong well in that unit. Harper so refers *P. duroides* and unites *P. Johnsoniana* with the *Caperata* group, very evidently an erroneous conception.

SECTION II. TRUNCIGENI

6. The Marginata Group.—Spores mostly slightly rough at maturity. Cystidia present, flask-shaped, with a narrow projecting neck (fig. 83). Rather small plants, with glabrous, hygrophanous pileus, striatulate when moist, watery-brown, drying to ochraceous or cinnamon.

P. marginata, P. unicolor, P. discolor, P. furcata.

Harper includes *P. marginella* and *P. mutabilis* here, but they differ in having slightly truncate spores and in lacking cystidia.

7. The Mutabilis Group.—As in the *Marginata* group but spores slightly truncate, smooth, and cystidia absent.

P. mutabilis, P. marginella.

8. The Cerasina Group.—Reddish or ochraceous-orange species with glabrous pileus, not hygrophanous. Cystidia none. Spores smooth or rough.

P. cerasina, P. oregonense, P. rubecula.

9. The Spectabilis Group.—Gills bright-colored (yellow or ochraceous-orange and remaining so on drying). Pileus dry, scaly. Spores rough.

P. spectabilis, P. luteofolia, P. aeruginosa, P. curvipes (?).

10. The Adiposa Group.—Spores smooth. Pileus often viscid, decidedly scaly. Stem usually scaly. With brown cystidia in the hymenium. Large plants, fleshy and heavy, yellowish colors predominating.

P. adiposa, P. aurivella, P. aurivelloides, P. squarrosa, P. squarrosoides, P. flammans, P. rigidipes.

I have united here two groups, the *Adiposa* group and the *Squarrosa* group of Harper, although they can be maintained distinct on the basis of the different type of scaly covering on the pileus. *P. limonella,* I would prefer to class in the *Tuberculosa* group, rather than here as in Harper's synopsis. *P. flammans* departs from the other species of the group in the small stature and the small spores. *P. rigidipes* has all of the characters of this group except for the sparsely scaly pileus and stem, and the more slender stature.

11. The Tuberculosa Group.—Spores smooth. Pileus viscid, and both pileus and stem scaly. No cystidia. Small plants of bright color, red or orange predominating.

P. tuberculosa, P. lucifera, P. limonella.

P. curvipes might be expected here rather than in the *Spectabilis* group, but departs from the characters enumerated above in the lack of viscidity on the pileus.

12. The Muricata Group.—Small plants with erect-pointed dark scales on pileus and stem. No cystidia. Spores smooth.

P. muricata, P. erinaceella.

13. The Fulvo-squamosa Group.—Large plants with fibrous cuticle that soon separates into scales. Not viscid. Spores smooth. Cystidia hyaline if present. Taste and odor of radishes.

P. fulvo-squamosa, P. Schraderi.

In general these two species are somewhat similar but neither is well known.

Unattached species of the Truncigeni.—(1) *P. Aegerita.* Close to the *Mutabilis* group in some respects but the evidence is not clear. (2) *P. albocrenulata.* Is really the type of a distinct group, with its large ellipsoid spores 11–15 μ long. (3) *P. destruens* is a well-marked type which should be set off by itself or with *P. comosa* and *P. heteroclita* if either of these should be held distinct.

SECTION III. MUSCIGENI

14. The Mycenoides Group.—Very small plants among *Polytrichum* or *Sphagnum* mosses.

P. mycenoides, P. minima.

There can really be no relationship between the two species included here. The former has smooth truncate spores 9–11 μ long, and the latter has spores not truncate, rough-walled, and 6–8.5 μ long. The relationships of the former may be with the *Togularis* group.

As to the inter-relations of these groups little that is definite can be hazarded. In some respects the *Caperata* group might be considered as the more advanced of the *Humigeni*. This argument would utilize the fact that in *P. caperata* at least there is present a more or less definite universal veil that leaves at times a second annulus-like structure comparable to an imperfect volva, at its base. For that reason the species is sometimes separated off in the genus *Rozites*. The spores are rough-walled, which, other things being equal, must probably be considered an advanced character. Yet otherwise the organization of the hymenium is not so complex as in many other species. Yet each of these groups in the *Humigeni* presents at least one such mark of advancement, assuming that the more complex structures indicate advance in proportion.

In the *Truncigeni*, the *Marginata* group represents probably the most advanced condition in one line of development, but is probably exceeded in another line by the *Adiposa* group, in some species of which one finds the most highly organized sporophores in the genus. The development of cystidia, the high degree of coloration, and the presence of an internal medulla in the trama of the gills (figs. 142, 137, 131, 129, etc.) are marks of advance over plants with the opposite of these characters.

That either these sections or phylogenetic units can be considered as genera is unthinkable. The practice of breaking up the large genera of the fungi does not commend itself, in general, as the proper plan of procedure. In a considerable part of such work that has appeared the limits of genera encroach too closely on those of species. There is still room and use in the taxonomic literature for such a group as the *Sub-Genus* or the *Section*, and the confusion that results in attempting to fit new generic names to old ideas that are well established is lamentable.

VII. Acknowledgments

In the preparation of this paper I have had access to a considerable series of European specimens from Romell and from Bresadola and have studied our plants with reference to them. As a result, some of my conclusions as to the identity of our species are at variance with those of my predecessors. The majority of the specimens with which I have worked are preserved in five different herbaria: that of the New York Botanical Garden, which contains by far the most extensive collection; Peck's herbarium at Albany, in the New York State Museum; the herbarium of the Missouri Botanical Garden at St. Louis; the herbarium of the Pennsylvania State College at State College, Pa.; and in my own herbarium. My identifications are on the specimens in all of these places, so that I have not felt it necessary to present here all of the data required to identify the particular collections. Consequently, my citation of specimens is limited to data that concerns only the stations involved, from which the geographical range may be obtained at a glance.

Acknowledgments for assistance are gladly given to Dr. W. A. Murrill and the New York Botanical Garden for free access to all collections of the genus at that institution; to Dr. H. D. House for the privilege of studying the many collections in the New York State Museum at Albany; to the Missouri Botanical Garden for access to the herbarium there; to the officials of the Pennsylvania State College for their interest and indulgence in the work; to Dr. R. A. Harper and the Wisconsin Academy of Sciences, Arts, and Letters for permission to reproduce some of the plates published by the late E. T. Harper; likewise to Mr. L. W. Brownell of Paterson, N. J., for original photos presented in plates 16, 17, 20, 21, and 24; to Mr. Burtt Leeper, Salem, Ohio, for plate 18; to Mr. W. S. Odell for plate 12 (photo by Drayton); to Dr. E. T. Harper for the photo in plate 11, sent to me a short time prior to his death; to Mrs. Edna G. Stamy Fox for the final touches that have contributed so much to the appearance of the text figures; and to many others who have contributed specimens or in other ways have aided in the prosecution of the work.

VIII. Taxonomic Considerations

PHOLIOTA

Pholiota Fries, Syst. Myc. 1: 240. 1821.

Plants fleshy, putrescent, solitary to cespitose, geophilous or xylophilous; pileus glabrous to floccose, fibrillose, or distinctly scaly; lamellae adnexed to slightly decurrent; stem central, fleshy, glabrous to fibrillose or scaly, continuous with the flesh of the pileus; veil present, usually membranous, sometimes fibrillose, forming a distinct, though often evanescent, annulus; spores ochraceous-brown to ferruginous or fuscous, smooth or rough; cystidia often present.

Type species: *Pholiota dura* (Bolt.) Fries.

The plants in this genus are analogous to those in *Armillaria* of the white-spored series and in *Stropharia* of the purple-brown-spored series. At some points the genus grades into *Flammula*, due to the early disappearance of the partial veil or the annulus, and in *Flammula* the veil fragments may at times persist as an incomplete annulus.

Key to the Species[1]

1. Plants at maturity not more than 4 cm. broad....2
   Plants at maturity 4–15 cm. or more broad....29
2. Plants growing on the ground or among mosses....3
   Plants growing on stumps, trunks, or rotting logs....14
3. Pileus distinctly fibrillose or squamulose, especially at the center....4
   Pileus entirely glabrous at the center, the margin occasionally with white fibers from the veil....5
4. Stem distinctly scaly below the sheathing veil remnants; gills bright cinnamon in dried plants; known only from Oregon; spores smooth, 5.5–6.5 × 3.5–4.5 μ....*20. P. terrestris*
   Stem not scaly, somewhat fibrillose; gills deep brown in dried plants; known only from Colorado; spores rough-walled, 7–9 × 5–6 μ....*19. P. trachyspora*
5. Plants growing among *Polytrichum* mosses....*18. P. minima*
   Plants growing in wet places among *Sphagnum* mosses....*9. P. mycenoides*
   Plants growing on the ground or on leaf mold....6
6. Pileus slimy-viscid; stem heavily white-floccose below the annulus; known only from Washington and Oregon....*22. P. albivelata*
   Pileus and stem not as above....7

[1] For a supplementary key to the species see p. 169. It should also be noted that the phylogenetic arrangement on p. 95 can be used as a key to small groups of species, and that the synoptical key in the text, beginning on p. 104, can be used to the same end.

7. Cystidia present and projecting conspicuously from the sides of the gills (figs. 40, 48) 8
Cystidia absent 11
8. Cystidia 15–20 μ in diameter at the broadest part; spores truncate at one end, 8–10.5 μ long 9
Cystidia 7–12 μ in diameter at the broadest part; spores not at all truncate, 10–15 μ long 10
9. Spores 4.5–6 μ broad .... *2. P. praecox*
Spores 6–7 μ broad .... *5. P. temnophylla*
10. Plants small, less than 2 cm. in diameter, uniformly fuscous in color; known only from Washington .... *13. P. subnigra*
Plants somewhat larger; lighter in color than the above; spores 10–12 μ long .... *11. P. platyphylla*
Plants as in the last but spores up to 15 μ long .... *12. P. erebia*
11. Stem 1–2.5 cm. long; pileus yellowish-red or dark ferruginous and not changing on drying .... *8. P. rugosa*
Stem 2–10 cm. long; pileus watery-brown, drying to ochraceous 12
12. Stem filiform, about 1 mm. thick; pileus not more than 2 cm. broad. .... *10. P. filaris*
Stem not filiform, 2 mm. or more thick; pileus at maturity more than 2 cm. broad 13
13. Spores 6.5–9 μ long .... *6. P. blattaria*
Spores 9–10.5 μ long .... *7. P. togularis*
14. Pileus entirely glabrous and hygrophanous,[1] the margin usually striatulate when moist (pl. 15) 15
Pileus scaly[2] or densely fibrillose from the first or becoming so in mature plants; hygrophanous only in *P. confragosa*, but often viscid 20
15. Stem distinctly scaly; gills not forked .... *30. P. mutabilis*
Stem not at all scaly; gills forked .... *28. P. furcata*
Stem not scaly; gills not forked 16
16. Pileus viscid when fresh .... *27. P. discolor*
Pileus not viscid 17
17. Stem hollow, with irregular transverse partitions; known only from California; on small twigs .... *21. P. anomala*
Stem stuffed or hollow, not internally partitioned; on logs or on sawdust 18
18. Cystidia absent; spores entirely smooth, slightly truncate at one end (fig. 95) .... *29. P. marginella*
Cystidia present, flask-shaped, projecting (fig. 83); spores not truncate, smooth at first, usually somewhat roughened when mature 19
19. Annulus funnel-shaped, persistent, conspicuous; pileus never more than 2 cm. broad .... *26. P. unicolor*
Annulus not funnel-shaped, sometimes persistent as a ring but often evanescent; pileus often 3–4 cm. or more broad .... *25. P. marginata*
20. Pileus dull cinnamon, dull tawny, or brown 21
Pileus bright-colored, i.e., pinkish-red, yellow, ochraceous-orange, or bright tawny in fresh plants 22

[1] i. e. watery-brown when moist, ochraceous as the pileus begins to lose moisture.

[2] Sometimes young specimens are only fibrillose, the scales appearing as the plant matures; sometimes the young plants are conspicuously scaly, the scales gelatinifying with age and often disappearing.

21. Pileus densely floccose-fibrillose or floccose-squamulose as seen under a lens . . . . *47. P. confragosa*
Pileus densely covered with small erect spine-like scales . . . . *48. P. erinaceella*
22. Spores 3–5.5 μ long; dried plants with a yellow pulverulent appearance. . . . . *38. P. flammans*
Spores 6 μ or more long; pileus not pulverulent 23
23. Pileus viscid when fresh 24
Pileus dry when fresh 26
24. Pileus lemon-yellow or bright sulphur-yellow 25
Pileus with greenish or purplish tinges and not uniformly nor brightly yellow . . . . *Flammula polychroa*[1]
25. Stem concentrically ringed or peronate with white fibrils . . . . *50. P. lucifera*
Stem not peronate, but with scattered recurved yellow scales . . *51. P. limonella*
26. Gills bright-colored, i.e., ochraceous-orange, bright ferruginous, or ochraceous-buff, and remaining so in dried plants 27
Gills not bright-colored, rather cinnamon or brown 28
27. Young plants bright-colored and only silky, becoming scaly and tawny when mature; taste mild; spores smooth . . . . *53. P. curvipes*
Young plants dark red and plush-like, becoming somewhat areolate and pinkish-red when mature; taste bitter; spores minutely roughened (fig. 107) . . . . *35. P. luteofolia*
28. Pileus drying brown or cinnamon-brown, densely covered with tawny fibrils or tufted and sub-erect scales (pl. 14, fig. 3); stem not bulbous . . . . *49. P. muricata*
Pileus drying ochraceous-tawny with dark innate squamules; stem with a distinct bulb just at base (pl. 14, fig. 4) . . . . *52. P. tuberculosa*
29. Plants growing on the ground and not around old stumps and logs or from buried wood 30
Plants growing on wood, on sawdust piles, or around old stumps or rotting logs, sometimes from buried wood 42
30. Pileus entirely glabrous or at most only with marginal fibers from the veil 31
Pileus fibrillose, floccose, squamulose, or scaly, at least over the center 37
31. Spores more than 10 μ long 32
Spores averaging less than 10 μ long 34
32. Cystidia pyriform to subglobose (figs. 1, 3, 5), not projecting conspicuously, about 20 μ in diameter; spores ovoid with a truncate apex (fig. 2) . . . . *1. P. vermiflua*
Cystidia elongated, projecting prominently (20–40 μ) (fig. 43), 5–7 μ in diameter; spores elongate-elliptic, not truncate 33
33. Pileus 2–5 cm. broad; gills 2–4 mm. broad . . . . *12. P. erebia*
Pileus 4–10 cm. broad; gills 4–6 mm. broad . . . . *14. P. ombrophila*
34. Plants western; pileus slimy-viscid; stem conspicuously white-tomentose just below the annulus . . . . *22. P. albivelata*
Plants eastern; pileus dry or very slightly viscid in very wet weather; stem not white-tomentose 35
35. Spores 4–6 μ long; annulus membranous, evanescent . . . . *23. P. duroides*

[1] This species is so frequently met and at times presents a fairly well-formed annulus, so I have thought it best to include it in the key at this point. No description is given in the text.

Spores 5–8.5 μ long; annulus not membranous but forming a cottony roll on the stem .... *24. P. Johnsoniana*
Spores 8–10.5 μ long 36

36. Plants growing on the ground in cultivated fields or grassy places, or in open grassy woods, or among straw or other waste vegetable matter carried into the woods; pileus not rugose .... *2. P. praecox*
Plants growing on the ground in dense woods; pileus not rugose .. *4. P. Howeana*
Plants growing on very rich humus around rotting logs; pileus rugose at times .... *3. P. Acericola*

37. Spores 12–17 μ long, decidedly rough-walled (fig. 58) 38
Spores 9–12 μ long, smooth or nearly so .... *15. P. aurea*
Spores 6–9 μ long, decidedly rough-walled (fig. 64) .... *19. P. trachyspora*
Spores 6–9 μ long, entirely smooth 39
Spores 4–6 μ long, smooth .... *23. P. duroides*

38. Pileus dry or moist, in youth showing fine whitish fibrils under a lens; plants eastern .... *16. P. caperata*
Pileus slimy-viscid, glabrous; plants western .... *17. P. Mcmurphyi*

39. Pileus very slightly squamulose only at the center .... *24. P. Johnsoniana*
Pileus uniformly squamulose or nearly so 40

40. Cystidia present, rather abundant, hyaline, fusoid, projecting rather prominently (fig. 149a) .... *46. P. Schraderi*
Cystidia absent or represented by small inconspicuous brown bodies in the hymenium 41

41. Scales of the pileus rather large, scattered; pileus yellow or buff in color .... *45. P. rigidipes*
Scales of the pileus minute and dot-like (pl. 23), abundant; pileus brown or pinkish-cinnamon .... *54. P. angustipes*

42. Pileus glabrous or essentially so at all stages 43
Pileus more or less distinctly fibrillose or scaly 48

43. Pileus watery-brown, cinnamon, yellowish, or pale tan, or drying somewhat brighter, hygrophanous; cystidia present, sometimes quite rare 44
Pileus with more red in its coloration, ochraceous-buff to reddish-yellow or tawny, concolorous or darker in dried plants; not hygrophanous; cystidia none 46

44. Spores truncate at one end (figs. 10, 14), smooth; cystidia 15–20 μ in diameter in the broadest part, not with an elongate tip (figs. 9, 11) .... *3. P. Acericola*
Spores not truncate, smooth; cystidia 6–10 μ in diameter in the broadest part, not with an elongate tip (fig. 98) .... *31. P. Aegerita*
Spores not truncate, rough-walled at least at maturity; cystidia 10–15 μ in diameter in the broadest part, with an elongate tip (figs. 83, 89) 45

45. Pileus viscid .... *27. P. discolor*
Pileus dry or moist .... *25. P. marginata*

46. Stem 3–6 cm. long .... *34. P. rubecula*
Stem 6–15 cm. long 47

47. Spores rough-walled (fig. 103); gills not interveined; plants known only from the eastern states .... *33. P. cerasina*
Spores smooth; gills strongly interveined; plants known only from Oregon .... *32. P. oregonense*

48. Spores averaging 4–6 μ long 49
Spores averaging 6–11 μ long 50
Spores averaging 11–14 μ long .... *39. P. albocrenulata*
49. Pileus lemon-yellow, zinc-orange, or tawny, with concolorous floccose-fibrillose, sub-appressed scales; stem 2–5 mm. thick .... *38. P. flammans*
Pileus pale cinnamon or cinnamon-buff, with concolorous erect-pointed scales (pl. 22); stem 5–12 mm. thick .... *43. P. squarrosoides*
50. Gills bright-colored, i.e., yellow, bright ferruginous, or ochraceous-orange, and remaining so in dried plants 51
Gills cinnamon to dark ferruginous, tawny, or brown 53
51. Pileus with greenish tints and strongly areolate from an early stage (pl. 18); spores slightly roughened (fig. 113) .... *37. P. aeruginosa*
Pileus pale pinkish-red, frequently slightly areolate at the center; spores slightly rough (fig. 105) .... *35. P. luteofolia*
Pileus apricot-yellow to zinc-orange or tawny, not at all areolate 52
52. Spores rough (fig. 109); pileus 4–15 cm. broad; stem 0.5–3 cm. thick .... *36. P. spectabilis*
Spores smooth; pileus 2–5 cm. broad; stem 2–5 mm. thick .... *53. P. curvipes*
53. Plants with *one* of the following characteristics:
(a) Spores decidedly rough-walled (fig. 109) .... *36 P. spectabilis*
(b) Pileus uniformly covered with minute dot-like scales (pl. 23) scarcely visible except under a lens .... *54. P. angustipes*
(c) Pileus with large white floccose patches or soft white scales .... *56. P. destruens*
Plants with none of the above characters 54
54. Pileus dry 55
Pileus viscid or slimy-viscid 58
55. Cystidia entirely lacking 56
Cystidia at least in part as brown organs among the basidia 57
Cystidia altogether hyaline, projecting prominently (fig. 149a) .. *46. P. Schraderi*
56. Pileus 2–6 cm. broad, with small scales; stem 1.5–3 cm. long, 1–5 mm. thick .... *52. P. tuberculosa*
Pileus 6–12 cm. broad, with a conspicuous fibrous-scaly covering (pl. 13); stem 5–8 cm. long, 8–10 mm. thick .... *55. P. fulvo-squamosa*
57. Pileus with many large recurved, often floccose scales (pl. 21); veil forming a thick persistent floccose annulus; stem conspicuously scaly .. *44. P. squarrosa*
Pileus with scattered appressed inconspicuous scales; veil forming a slight often evanescent annulus; stem only slightly scaly .... *45. P. rigidipes*
58. Cystidia none; plants less than 5 cm. broad at maturity 59
Cystidia abundant, hyaline, flask-shaped, projecting; pileus 2–7 cm. broad .... *Flammula polychroa*[1]
Cystidia as brown organs between the basidia (fig. 127a, 135a); mature pileus 5–15 cm. or more in diameter 60
59. Stem marked with rings of white fibrils; spores 7–9 μ long .... *50. P. lucifera*
Stem not so marked; spores 6.5–7.5 μ long .... *51. P. limonella*
60. Spores 9–11 μ long; known only from Colorado, New Mexico and Wyoming .... *40. P. aurivelloides*
Spores mostly 7–9.5 μ long, occasionally slightly longer 61

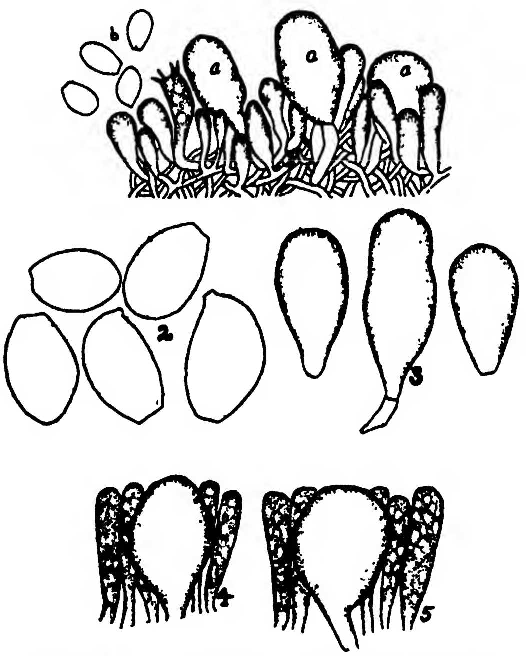
[1] See footnote, bottom p. 101.

61. Pileus with large appressed, spot-like scales; stem increasingly scaly downward; pileus tawny or rusty in color..................41. *P. aurivella*
Pileus with medium-sized scales, often recurved; stem increasingly scaly upward; pileus yellow to zinc-orange........................42. *P. adiposa*

I. *Spores with a truncate apex (fig. 2) (see also II, p. 117).*
A. Cystidia present in the hymenium: largest plants more than 4 cm. broad (see also B, p. 113).
1. Spores 10–14 μ long.

1. Pholiota vermiflua Peck, Rept. N. Y. State Mus. **31**: 34. 1879. Pl. 8.

Pileus 2–12 cm. broad, hemispheric to campanulate or plane, white, cream-color or massicot-yellow, retaining these colors in drying, dry or moist or in wet weather almost viscid, glabrous or the margin fibrillose from the veil, the center often becoming reticulate-areolate at maturity; flesh rather thick, often with a slightly disagreeable taste, pure white; gills slightly uncinate to broadly adnate or sinuate, close, 3–10 mm. broad, white then dark brown, ochraceous-tawny to buckthorn-brown in dried plants; veil white, membranous, forming a superior, often evanescent annulus, or adhering to the margin of the pileus; stem central, equal or more often enlarged at the apex and tapering to a somewhat bulbous base, white or light brown, fibrillose or glabrous, sometimes striate and pruinose at the apex, solid or with a small hollow, 5–12 cm.



Figs. 1–5. *P. vermiflua:* 1, section of hymenium of the type specimens showing the inflated cystidial cells (a) and the spores (b), ×550; 2, spores, ×1200 (note the truncate apex); 3, three isolated cystidia from the type specimens, × 550; 4 and 5, more globose cystidia not projecting, × 550.

long, 3–15 mm. thick; spores ovoid or elliptic, more or less truncate at the apex, smooth, 10–14 × 6–8 μ; cystidia present, subglobose to pyriform with a tapering base, 35–45 × 20 μ, not prominent, sometimes quite rare.

Habitat: on the ground in cultivated, grassy, or waste places; not in dense woods.

Distribution: specimens have been examined from Cambridge, Mass.; Ticonderoga, Rochester, Menands, Bronx Park, and Scarsdale, N. Y.; State College, Pa.; Chapel Hill, N. C.; West Elkton, Ohio; Greencastle, Ind.; Lexington, Ky.; St. Louis, Mo.; Rooks Co., Kan.; Denver, Colo.; Berkeley and San Francisco, Cal.

Illustration: Harper, Trans. Wis. Acad. Sci. **17**: *pl. 28 C–F, 29;* **18**: *pl. 11–13* (as *P. dura*).

Closely related to *P. praecox* with which it has often been confused. The larger spores will invariably separate it from that species. The thin, slender-stemmed, *Panaeolus*-like form with a rich brown color to the gills grades over gradually into the thick, heavy, fleshy form with areolate pileus. This species is apparently *P. dura* Bolt. of Europe, often reported from this country, but the final evidence that the two are the same is yet lacking. If they are identical then all the earlier descriptions and spore measurements reported for *P. dura* are erroneous, and based on the fleshy forms of *P. praecox*. Bresadola gives the clue to the situation in describing *P. dura xanthophylla*, in which he reports the spores as 10–12 μ long, and indicates that in the true *P. dura* they are the same, although all earlier records report them as approximately 8–10 μ long; Ricken and Lange, in their recent work on the *Agaricaceae*, also give a difference in spore measurements as indicated above. From these facts I conclude that in all probability the plants described here as *P. vermiflua* represent the true *P. dura*, and the species is distinct in the larger spores. In *P. praecox* they rarely reach a length of more than 10 μ.

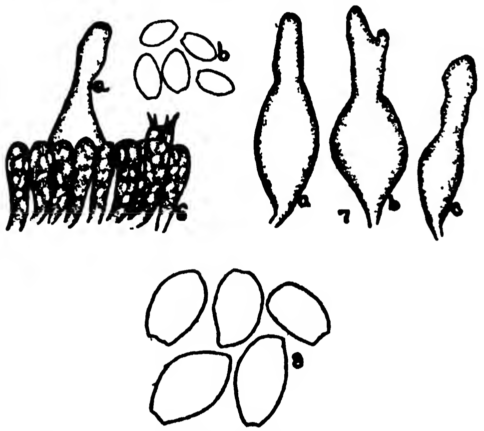
Hebeloma hortense Burt, recently described from Missouri, probably belongs here as an evelate form. Cooke's illustration of *P. dura* represents that species quite well except for the veil. See further under *P. praecox*.

2. Spores 8–10.5 μ long.

2. **Pholiota praecox** (Pers.) Fries, Syst. Myc. 1: 282. 1821.

Agaricus praecox Pers. Comm. Fung. Bavar. 89. 1800. Pl. 9.

Pileus 2–14 cm. broad, convex to campanulate or nearly plane, sometimes umbonate, often fuscous or fuscous-black when very young, soon whitish or cream-color, often tinged with yellow or tan, or the center brownish, or in wet weather uniformly tan, usually ochraceous or tan in herbarium specimens, hygrophanous in wet weather, soft, glabrous, or at times as though finely tomentose, dry or moist, areolate in dry weather or in large specimens; flesh white, odor and taste strongly farinaceous; gills sinuate-adnate to broadly adnate or with a very slight decurrent tooth, medium-close, whitish, becoming brown or rusty-brown, honey-yellow to clay-color or snuff-brown in herbarium specimens, 3–12 mm. broad; veil membranous, forming a white, superior, persistent or evanescent annulus, or partially adhering to the margin of the pileus; stem central, equal or somewhat bulbous below, whitish, pruinose-mealy to slightly fibrillose, squamose, furfuraceous, or becoming nearly glabrous, often striate above the annulus, stuffed or hollow, 3–15 cm. long, 3–20 mm. thick; spores ovoid, usually with a truncate apex, smooth, deep brown, 8.5–10 × 4.5–6 μ; cystidia present, flask-shaped or ventricose, sometimes rare, projecting somewhat, 14–18 μ in diameter.



Figs. 6–8. *P. praecox:* 6, section of the hymenium showing a cystidium (a) and the spores (b), × 550; 7, three types of cystidia isolated from the hymenium, × 550; 8, spores, × 1200. All from Overholts Herb. 3318.

Habitat: on grassy ground, in lawns, fields, etc.; sometimes on the ground in open woods, or on straw or other litter carried into woods.

Distribution: specimens have been examined from Boston, Mass.; Washington, D. C.; Bronx Park, Whitestone, Lake Placid, and Syracuse, N. Y.; Philadelphia Co., and State College, Pa.;

West Elkton, Ohio; Tolland, Lake Eldora, and South Boulder Cañon, Colo.; Berkeley, Santa Barbara, and Del Monte, Cal.; Corvallis, Ore.; Seattle, Wash.; Banff, Alberta, Canada; Yakutak Bay, Aqua Dulce River, and Muir Glacier, Alaska. Also reported from Illinois by Harper, and from Michigan by Kauffman.

Illustrations: Atkinson, Mushrooms, *pl. 42;* ed. 2, *pl. 46;* Berkeley, Outl. Brit. Fung., *pl. 8, f. 1;* Bresadola, Fung. Mang. *pl. 49;* Cooke, Ill. Brit. Fung. *pl. (360) 381;* Gillet, Champ. Fr. *pl. (292) 524;* Hard, Mushrooms, *f. 209;* Harper, Trans. Wis. Acad. Sci. **17**: *pl. 27, 28 A, B;* Kauffman, Agar. Mich. *pl. 59;* Murrill, Mycologia **3:** *pl. 49, f. 1;* Patouillard, Tab. Anal. Fung. *f. 112;* Peck, Rept. N. Y. State Bot. **49:** *pl. 46;* Peck, N. Y. State Mus. Mem. **3:** *pl. 57.*

This is undoubtedly our most common *Pholiota* and undoubtedly grows in every state in the Union. I find it to be abundant in May and June in Pennsylvania, and it was just as common in Colorado in June and July at elevations ranging up to nearly 10,000 feet. The annulus formed is usually ample and membranous, but rather fragile, and apt to disappear early, or may all but fail to develop, and may hang to the margin of the pileus instead. Most writers have remarked of the close relationship of this species to *P. dura,* a species that does not occur in America unless represented by *P. vermiflua* (which see). The spores are distinctly smaller than in that species, however. Kauffman's record (9–13 × 6–7 μ) probably includes spores from both species, while Harper's record of *P. dura* is undoubtedly this species.

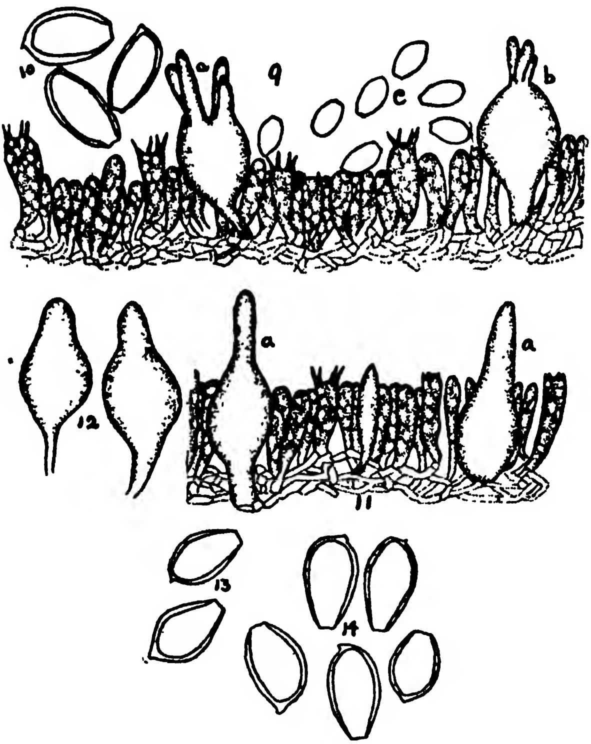
At different times reports have reached the writer of the existence of an evelate and exannulate form of this species or of *P. dura.* These are the plants recently described by Dr. Burt from St. Louis, Mo., as *Hebeloma hortense* n. sp. The writer collected this plant in abundance in the Missouri Botanical Garden as early as April, 1914. No sign of a veil is to be found and the plant has much of the characteristic habit of the short-stemmed form of *P. praecox* or of *P. vermiflua.* The pileus may become considerably areolate in dry weather or with age, and the spores give the larger measurements of those of *P. vermiflua,* and have the same characteristic ovoid shape with a truncate apex. Cystidia similar to those in *P. vermiflua* have been noted in sec-

tions of these plants. It seems quite likely that *Hebeloma hortense* is a recent variation from *P. vermiflua* (= *P. dura*), and our imperfect system of Agaric classification necessitates its reference to the former genus.

A sterile form of *P. praecox* is described by Murrill from the vicinity of New York City.

3. **Pholiota Acericola** Peck, Bul. Buffalo Soc. Nat. Sci. 1: 50. 1873. Pl. 10.

Pileus 2.5–7.5 cm. broad, broadly convex or nearly plane, rarely somewhat umbonate, cream-buff to clay-color or buckthorn-brown when young and moist, buff-yellow or Naples-yellow when old, the center frequently somewhat darker than the margin, not strongly hygrophanous but changing color from young to old condition, glabrous, clay-color to tawny in herbarium specimens, often rugosely reticulated or corrugated; margin even, sometimes upturned; flesh thin, white, taste and odor farinaceous; gills sinuate-adnate or with a small decurrent tooth, medium-close, 2.5–7 mm. broad, grayish,



Figs. 9–14. *P. Acericola:* 9, section of the hymenium, showing the peculiar three- or four-pointed cystidia (a and b), and the spores (c), × 550; 10, spores, × 1200 (Overholts Herb. 3986); 11, section of the hymenium showing flask-shaped cystidia (a) (Overholts Herb. 984); 12, isolated cystidia, × 550 (Overholts Herb. 3953); 13, spores, × 1200 (Overholts Herb. 3765); 14, spores, × 1200 (Overholts Herb. 3911).

becoming brownish-ferruginous or at some stages with a purplish cast, the edge floccose-crenulate; veil forming a large, persistent, or rarely evanescent, membranous, superior or in some instances nearly median, deflexed, white annulus, sometimes of a rich brown color and striate on the upper side; stem central, equal or thickened at the base, fibrillose-striate to nearly glabrous, white or whitish, stuffed or hollow, typically with more or less of a white tomentum and strings of mycelium at the base, 6–11 cm. long, 4–15 mm. thick; spores ovoid or ovoid-elliptic, with a truncate apex, smooth, dull brown, 8.5–10.5 × 5–6 μ; cystidia present but not abundant, flask-shaped or broadly fusoid but only the tips projecting, rather conspicuous, the tips rarely two- to three-forked, 15–20 μ in diameter below.

Habitat: mossy rotted trunks of deciduous trees, perhaps also on coniferous wood; rarely on the ground around rotting logs or on leaf mold.

Distribution: specimens have been examined from Bar Harbor, Me.; Redding, Conn.; Lake Placid, Arkville, Bronx Park, Sand Lake, Raybrook, Van Cortlandt Park, and East Worchester, N. Y.; Falls Church, Mountain Lake, Crabbottom, and Blacksburg, Va.; Pink Bed Valley, N. C.; Auburn, Ala.; State College and Gray's Run, Lycoming Co., Pa.; Oxford, Ohio; St. Louis, Mo.; Tolland, Colo.; Santa Cruz, Cal.; also reported from Michigan by Kauffman.

This is one of our most common species and as here admitted is found to range from the Atlantic to the Pacific. The distinguishing characters are the ochraceous color, the slender habit, the ample persistent membranous annulus, the truncate spores, and the white mycelial strands at the base of the stem. Peck's original collection was from old maple logs, and I have tried to limit the species to a woody substratum but it is impossible. I would like to separate *P. sphaleromorpha* as a distinct geophilous species as based on European specimens at New York, but it is manifestly impossible, at least with our present knowledge of the plants. Bulliard's original illustration fits our plant remarkably well. Patouillard (Tab. Anal. Fung. *pl. 645*) shows a rosy or purplish tint to the gills of that species very comparable to the color of the gills in our specimens. A collection from Colorado

in my own herbarium (1866) is remarkably similar to authentic European interpretations of *P. sphaleromorpha*, but it grew on a rotten log and can as well be referred to *P. Acericola*, although the spores are a trifle broader and only inconspicuously truncate. Microscopically these plants all agree in their characteristic ovoid spores with truncate apex, and in the cystidia. In some specimens I find cystidia of peculiar shape with two or three or four cylindrical projections at the tips, so that except for the lack of vertical walls in the enlarged base the entire organ is almost an exact picture of the longitudinally septate basidium of a *Tremella* (fig. 9a). This throws an interesting side-light on the origin of cystidia, as these four projections are undoubtedly a prolific development of the usual four sterigmata of the basidium.

Numerous collections were found at New York to be referred to the genus *Stropharia*, as the slight purplish tint of the gills might indicate. The habit, especially where the plants are growing on rich humus, is very much like that of *Agaricus silvicola* or *A. placomyces*. Specimens growing on the ground are likely to be mistaken for *P. praecox* which is not usually a woodland plant. The spores are sometimes slightly wedge-shaped at the base, giving them an appearance of being obscurely 5-angled as reported by Kauffman. Several other species show this same character.

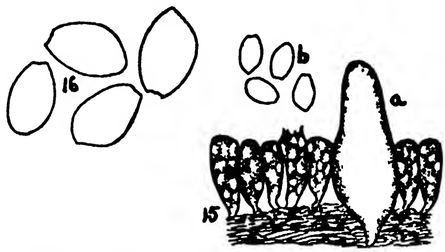
In view of its wide distribution Harper's failure to identify this species as a member of the flora of the Great Lakes Region is somewhat surprising.

4. **Pholiota Howeana** Peck, Rept. N. Y. State Mus. **26**: 59. 1874.

Stropharia Howeana Peck, Bul. Buffalo Soc. Nat. Sci. **4**: 53. 1873.

Pileus 2.5–8 cm. broad, convex then plane, subumbonate, yellowish or yellowish-brown, sometimes lighter and slightly rugulose when mature, sometimes darker in the center, dry, even, glabrous; margin even; context fragile, fleshy, bitter to the taste; gills sinuate-adnate or with a decurrent tooth when young, often entirely separating and leaving a distinct trace on the stem, whitish, becoming ferruginous-brown, rather close, eroded and lighter-

colored on the edge; veil forming a conspicuous, persistent, superior annulus; stem central, equal or slightly thickened at the base, colored similar to the pileus, glabrous, or the base white-tomentose, hollow, 5–11 cm. long, 4–7 mm. thick, sometimes with white mycelial cords at the base; spores ovoid or ovoid-elliptic, truncate at the apex, smooth, dilute brown, 8–10 × 4.5–5.5 μ; cystidia present but quite rare, broadly flask-shaped, projecting, hyaline.



Figs. 15–16. *P. Howeana:* 15, section of hymenium, showing a cystidium (a), and spores (b), × 550; 16, spores, × 1200. All from type specimens.

Habitat: on the ground in woods and bushy places, often among grass.

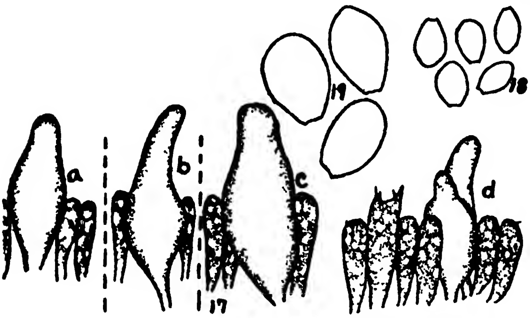
Distribution: reported, in addition to the type locality, Center, N. Y., from Michigan by Kauffman.

I must admit my inability to distinguish this species among the several hundred collections I have examined, in both fresh and dried condition. Harper likens it to *P. sphaleromorpha*, and Patouillard shows that species with a rosy or purplish tint to the gills as would be indicated for Peck's plant by its original inclusion in the genus *Stropharia*. Undoubtedly, if it is a woods form, and I have met with it, I have referred the specimens to the terrestrial form of *P. Acericola*, but unless the color of the gills is well marked I hardly see how the species can be admitted. *P. sphaleromorpha*, as I have remarked in another place, is extremely similar to the terrestrial form of *P. Acericola*. My first sections of the type specimens of *P. Howeana* yielded no cystidia, but I have since found them to be present but quite rare. When present they are very similar to those in *P. Acericola*, but somewhat less narrowed at the neck. Kauffman reports the species as occurring in open grassy fields, while Peck says it occurs in woods and bushy places. The five-angled form of the spores stressed by Kauffman is not more marked in the types of *P. Howeana* than in *P. Acericola*, but the spores may be slightly broader in proportion to their length than in that species. I have so far seen no characteristics that would set it off from

P. praecox if it grows in grassy open places, nor from the terrestrial form of *P. Acericola* if it grows in deep woods.

5. **Pholiota temnophylla** (Peck) Sacc. Syll. Fung. 5: 740. 1887.
Agaricus temnophyllus Peck, Rept. N. Y. State Cab. 23: 90. 1873.

Pileus 2.5–5 cm. broad, hemispheric becoming convex, ochraceous-yellow, cinnamon-buff to ochraceous tawny in dried plants, smooth, glabrous, dry; gills obliquely sinuate-adnate, medium-close, 4–8 mm. broad, brownish-ferruginous; veil membranous, white, forming a distinct, superior, persistent annulus; stem central, equal, white, glabrous, hollow, 5–10 cm. long, 4–8 mm. thick; spores elliptic to ovoid, one end usually slightly truncate, smooth, 9–10.5 × 6–7 μ; cystidia present but rather rare, flask-shaped or fusoid, hyaline, 17–21 μ in diameter, projecting prominently.



Figs. 17–19. *P. temnophylla:* 17, sections taken at different places along hymenium, showing various types of cystidia (a-d), × 550; 18, spores, × 550; 19, spores, × 1200. All from type specimens.

Habitat: grassy ground by roadside.

Distribution: known only from the type locality, Sand Lake, N. Y., except as reported by Harper from Illinois and by Kauffman in Michigan.

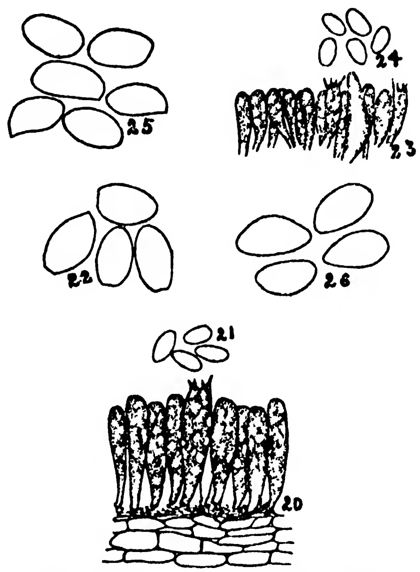
Illustration: Harper, Trans. Wis. Acad. Sci. 17: *pl. 33, A.*

I have been unable to detect this species in my own collecting grounds or in the herbarium material examined. It is evidently too close to *P. praecox* to be recognized from dried plants unless the broader apex of the cystidia will be an aid. I did not locate the cystidia in my first sections of the type material but a later examination showed their presence, but they are not abundant. Harper's specimens were identified by Peck. The obliquely and strongly truncate proximal edge of the gills is stressed as an important character.

B. Cystidia absent from the hymenium; largest plants not more than 4 cm. broad.
1. Spores 6–9 μ long.
a. On wood.
See II B 1b, Nos. 29 and 30 (P. mutabilis and P. marginella).
b. On the ground.

6. Pholiota blattaria Fries, Syst. Myc. **1**: 246. 1821.

Pileus 1–4 cm. broad, convex to plane, obtuse or more often somewhat umbonate, clay-color to ferruginous or hazel, ochraceous or cinnamon-buff on drying, hygrophanous, glabrous, the margin striate or striatulate when moist, often becoming somewhat rugose on parting with the moisture; flesh concolorous, odor none, taste mild; gills rounded behind, soon becoming free, 2–4 mm. broad, close, ventricose, clay-color to cinnamon; veil forming a subpersistent superior or median annulus, often striate on the upper side; stem central, equal or tapering upward, covered with small white fibrils either entirely or only at the base, whitish or slightly brownish, hollow, 2.5–5 cm. long, 2–4 mm. thick; spores ovoid or narrow-ovoid, sometimes with a slightly truncate apex, 6.5–9 × 4–5 μ; cystidia none.



Figs. 20–26. *P. blattaria:* 20, section of hymenium showing basidia, × 550; 21, spores, × 550; 22, spores, × 1200 (from specimens at New York, collected on Long Island by Dodge and Seaver); 23, section of hymenium of No. 967, × 550; 24, spores of same, × 550; 25–26, various types of spores from same collection, ×550.

Habitat: on the ground in wooded or grassy places.

Distribution: specimens have been examined from Long Island, N. Y.; Oxford, Ohio; and St. Louis and Meramec Highlands, Mo.

Most European writers assign spore measurements of 6–8 μ in length to *P. blattaria*, and Peck's basis for separating *P. rugosa* from this species was on the larger spores that are 8–10 μ long as in *P. togularis* Bull. (non Fries). The only specimens of this

group with the shorter spores that I have seen are those collected on Long Island by Dodge and Seaver, a collection by Trelease and one by myself from Missouri, and one from Ohio.

2. Spores 9–11 μ long.

7. **Pholiota togularis** (Bull.) Quel. Champ. Jura Vosges, 92. 1872. Pl. 15.

Agaricus togularis Bull. Herb. Fr. *pl. 595, f. 2.* 1793.

Pileus 1–4 cm. broad, campanulate or convex, becoming nearly plane, watery-brown when fresh, hygrophanous, becoming ochraceous on drying, warm-buff or ochraceous-buff in dried specimens, the margin striatulate when moist, glabrous, even or perhaps rugose at times; gills sinuate and narrowly attached, medium-close or subdistant, yellow becoming pale ferruginous, often ochraceous-buff in dried specimens; veil forming a conspicuous, persistent, median annulus, striate on the upper side; stem central, equal, yellow at the top and brownish at the base or entirely brownish, slightly fibrillose, hollow, 2.5–10 cm. long, 2–5 mm. thick; spores narrow-ovoid or ovoid, truncate at the apex, smooth, 9–10.5 × 4–6 μ; cystidia none.

Figs. 27–30. *P. togularis:* 27, section of hymenium showing basidia, × 550; 28, spores, × 550; 29, spores, × 1200. All from collection in New York State Museum, from North Elba, New York. 30, spores, × 1200, from collection at New York from Falls Church, Virginia, by Murrill.

Habitat: on the ground in woods or pastures.

Distribution: specimens have been examined from Falls Church, Va., and Stow, Mass.; also reported by Harper (as *P. blattaria*).

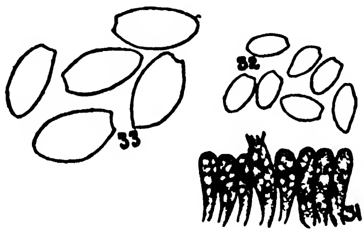
Illustrations: Bulliard, Herb. Fr. *pl. 595, f. 2;* Boudier, Ic. Myc. *pl. 101;* Cooke, Ill. Brit. Fung. *pl. 350 (379);* Gillet, Champ. Fr. *pl. 289 (528);* Harper, Trans. Wis. Acad. Sci. **17**: *pl. 59* (as *P. blattaria*).

This species seems to be well separated from *P. rugosa* by the larger stature throughout and the ochraceous or buff colors on drying. As here described the species is not *P. togularis* of Fries and perhaps Ricken, but compares well with the original il-

lustration of Bulliard. In this sense both Boudier and Patouillard have correctly described our plants, the plate given by the former being particularly good. *P. blattaria* as illustrated by Harper is more typical than any of those mentioned, however.

8. **Pholiota rugosa** Peck, Rept. N. Y. State Mus. **50:** 102. 1897. Pl. 15.

Pileus 8–25 mm. broad, broadly conic or campanulate to convex or plane, sometimes umbonate, yellowish-red or dark ferruginous, cinnamon or tawny in herbarium specimens, hygrophanous, glabrous, slightly rugose in the center; margin striate, often upturned in age; flesh very thin, concolorous, odor and taste not characteristic; gills at first adnate, becoming adnexed or free with age, medium-close, usually minutely denticulate on the edge, 1–3 mm. broad, yellowish white, becoming ferruginous or brownish-ferruginous, amber-brown in dried plants; veil forming a white, persistent, membranous, median annulus, striate on the upper side; stem central, equal or tapering upward, yellowish above, brownish or blackish-brown below, finely floccose below the annulus, pruinose or mealy above, hollow, 1–2 cm. long, 1.5–4 mm. thick; spores elongate-elliptic, slightly truncate at one end, smooth, 8–11 × 4–5 μ; cystidia none.



Figs. 31–33. *P. rugosa:* 31, section of hymenium showing basidia; 32, spores, × 550; 33, spores, × 1200. All from type specimens.

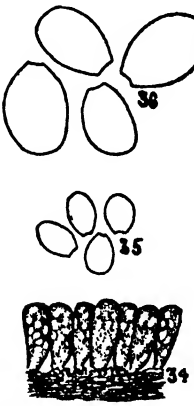
Habitat: on the ground in open woods; also in greenhouses.

Distribution: specimens have been examined from Adirondack Mts. and North Elba, N. Y.; State College, Pa.; also reported by Kauffman from Michigan.

While closely related to *P. togularis* Bull., the stature is smaller and the color is dark reddish-brown or ferruginous and remains so in herbarium specimens. *P. blattaria* is distinct in the smaller spores. I find the plant occurring on the ground in greenhouses.

9. **Pholiota mycenoides** Fries, Syst. Myc. **1:** 246. 1821.

Pileus 0.5–2 cm. broad, at first convex, at maturity plane, rather thin and membranous, rusty-brown when moist, buckthorn-brown to ochraceous-tawny in herbarium specimens, hygrophanous, drying first at the center and becoming ochraceous to deep cream-color, glabrous; margin widely striate and sometimes white-fibrillose from the cobwebby veil; flesh concolorous, odor none, taste mild or sub-farinaceous; gills adnate or somewhat sinuate, and becoming nearly free, sometimes uncinate, medium-close or slightly distant, rusty-brown, 2–3 mm. broad; veil forming a conspicuous, nearly median, membranous annulus, often striate on the upper side; stem central, equal or tapering upward, slender, pallid to brown, glabrous or nearly so, hollow, 4–10 cm. long, 1–3 mm. thick; spores ovoid or broadly ovoid. the apex truncate, smooth, 9–11.5 × 6–7.5 μ; cystidia none.



Figs. 34–36. *P. mycenoides:* 34, section of hymenium showing basidia, × 550; 35, spores, × 550; 36, spores, × 1200. All from Overholts Herbarium No. 2380.

Habitat: among mosses, especially *Sphagnum*, in swampy places.

Distribution: specimens have been examined from Stow, Mass.; also listed by Kauffman from Michigan on the basis of Beardslee's report.

Illustrations: Boudier, Ic. Myc. *pl. 102;* Cooke, Ill. Brit. Fung. *pl. 503 (405) B.*

Apparently a very rare species. The very slender plants, with long stem, narrow pileus, median annulus, and the truncate spores point to a relationship with the *P. togularis* group. The habitat is taken, by European writers, to be a characteristic feature of the species. We have in this country a plant somewhat similar to this species, but with a stem that is distinctly peronate with white fibrils and spores broadly elliptic without sign of truncate apex.

10. Pholiota filaris (Fries) Peck, Bul. N. Y. State Mus. 122: 144. 1908.

Pholiota togularis filaris Fries, Ic. Hym. 2: 2. 1877.

Pileus 0.5–2 cm. broad, campanulate or convex to plane, ochraceous when fresh, tawny or cinnamon-rufous in dried plants, glabrous, dry; margin striate, the striae visible in dried plants; flesh very thin; gills adnate, medium-close, yellow, becoming pale ferruginous, tawny or cinnamon-rufous in dried plants, 1–2 mm. broad; veil forming a distinct, persistent, median or superior though distant annulus, striate on the upper side; stem central, equal, glabrous or slightly fibrillose, pallid to brown, hollow, 2–5 cm. long, about 1 mm. thick; spores elongate-ellipsoid or elongate elliptic, often inequilateral, truncate at the apex, smooth, brown, 9–10.5 × 4.5–5 μ; cystidia none.

Figs. 37–39. *P. filaris:* 37, section of hymenium showing basidia, × 550; 38, spores, × 550; 39, spores, × 1200. All from collection at New York from Washington, by Murrill.

Habitat: on the ground in woods or pastures.

Distribution: specimens have been examined from Catskill Mts., N. Y.; Washington (state).

There seems to be room for a species in the *P. togularis* group with the following salient features: small size, slender habit, with *thread-like stem,* and large spores 9–10.5 μ long. However, it may intergrade too much into *P. togularis,* though the habit seems distinct enough. I have followed Peck in recognizing the species.

II. Spores not with truncate apex.

A. Growing on the ground or among moss (see also B, p. 132).

1. Plants with large spores 10–15 μ long (see also p. 125).

a. Plants 1–5 cm. broad at maturity (see also p. 120).

11. Pholiota platyphylla Kauffman, Papers Mich. Acad. Sci. **1:** 145. 1921.

"Pileus submembranous, 1–3 (4) cm. broad, convex, obtuse or obsoletely subumbonate, hygrophanous, 'tawny' (Ridg.) disk 'mars brown,' fading to 'antimony-yellow' or 'warm-buff,' obscurely striatulate on margin when moist, glabrous; flesh very thin on the incurved margin, concolor. Gills broadly adnate, decurrent by tooth, very broad, ventricose, close to almost sub-

distant, thin, at the very first pallid, soon 'clay color' to 'buckthorn-brown' (Ridg.). Stem 3–5 (6) cm. long, 2–4.5 mm. thick, equal, or slightly tapering upwards, subflexuous in age, stuffed, concentrically white-zoned from the delicate veil, zones terminating above middle of stem in a flaring, membranous, whitish annulus, white-scurfy above annulus, becoming at length silky or glabrous below, brownish within and without under the veil remnants, fuscescent. Spores subellipsoid, but narrower toward one end, inequilateral in one view, smooth, 10–12 × 5–6.5 μ, pale rusty brown, cystidia scattered on sides of gills, 60–70 × 9–11 μ, narrowly lanceolate above the slender pedicel, hyaline; sterile cells similar but narrower and crowded."

Figs. 40–42. *P. platyphylla:* 40, section of hymenium, a cystidium (a), and spores (b), × 550; 41, a single cystidium, × 550; 42, spores, × 1200. One spore showing the faint minute roughness. All from type specimens.

Habitat: on wet moss under pine and spruce along stream.

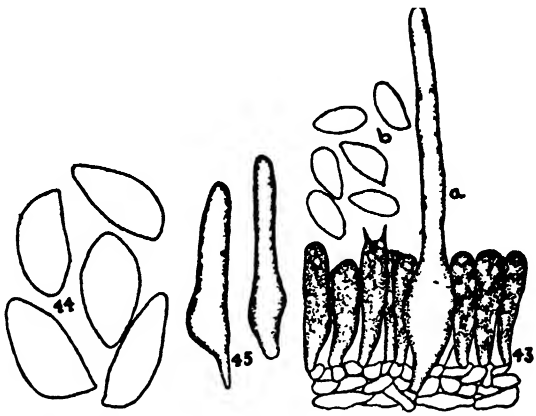
Distribution: known only from the type locality, Tolland, Colo.

I quote above the original description as given by Kauffman. I have seen only a fragment of the type collection but it appears to me to be too close to *P. erebia*, although in my mounts the spores run slightly smaller and the cystidia are much less numerous.

12. **Pholiota erebia** Fries, Syst. Myc. 1: 246. 1821. Pl. 11.

Pileus 1–5 cm. broad, convex becoming plane or slightly depressed, rarely slightly umbonate, at first brown or blackish-brown, drying out to umber, then ochraceous-tawny or buckthorn-brown, or slightly darker in herbarium plants, somewhat viscid when moist, glabrous or with a few white fibers on the margin, even or somewhat reticulate; margin slightly striatulate at times; gills adnate or slightly decurrent, medium-close or slightly distant, 2–4 mm. broad, pallid or grayish, becoming rusty-brown, ochraceous-tawny to cinnamon in dried plants; veil

forming a thin persistent, white, membranous, superior annulus; stem central, equal, brownish below, white and pruinose above the annulus, fibrillose or glabrous below, or at times slightly squamulose at the base, solid, 2.5–7 cm. long, 3–8 mm. thick; spores elongate-elliptic or elongate-ovoid, smooth, 11–15 × 5.5–7.5 μ; cystidia present, usually abundant, hyaline, 7–12 μ broad at the enlarged base, projecting 30–40 μ.



Figs. 43–45. *P. erebia*: 43, section of hymenium showing a cystidium (a), and spores (b), × 550; 44, spores, × 1200 (both from type specimens of *P. aggericola*); 45, isolated cystidia from collection at New York from Bronx Park by Murrill, × 550.

Habitat: on the ground by roadsides and in woods.

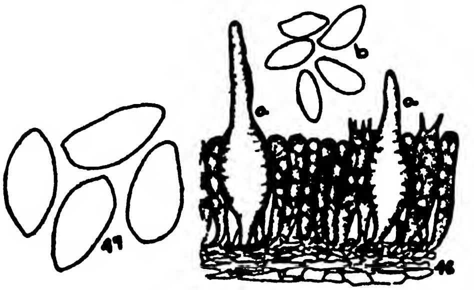
Distribution: specimens have been examined from Waltham, Mass.; Redding, Conn.; Bronx Park, West Park, North Greenbush, and Boltons Landing, N. Y.; Ridgewood, N. J.; St. Louis, Mo.; also reported from Wisconsin by Harper.

This species grades into *P. subnigra*, on the one hand, and into *P. ombrophila*, on the other, and cannot be sharply distinguished from them. In young specimens the pileus is brown or blackish-brown as shown by Peck's drawings on the type sheet at Albany, although the dried plants are distinctly cinnamon in color as they are in most other collections, but occasionally an immature plant retains the blackish color on drying as have the type specimens of *P. subnigra*, a western species, and as have the specimens at New York collected by Seaver in Bronx Park in 1913. Most collections that are referable here rather than to *P. ombrophila* are smaller plants that have narrow gills that are not decurrent, and the opposite of these characters is applicable to *P. ombrophila*. I am of the opinion, however, that we have one variable species which should include *P. aggericola*, *P. subnigra* Murrill, *P. washingtonensis* Murrill, *P. ombrophila*, and *P. erebia*. Ricken states

in the body of his text that the last two named are not distinct, but later he evidently changed his mind and added *P. ombrophila* in the Appendix.

13. **Pholiota subnigra** Murrill, Mycologia 4: 258. 1912.

Pileus 1.3 cm. broad, convex, slightly umbonate, uniformly fuscous or dusky-drab except on the margin where a hoary pubescence remains from the veil, otherwise glabrous, slightly viscid; gills sinuate-adnate, ventricose, medium-close, becoming fulvous, the edge whitish, 2 mm. broad; veil forming a persistent white superior membranous annulus; stem central, equal, pallid, rough with short soft whitish conic scales pointing upward, solid, 2 cm. long, 2.5 mm. thick; spores somewhat elongate-ellipsoid, smooth, 10–13 × 5–6 μ; cystidia abundant, projecting, conspicuous, flask-shaped.



Figs. 46–47. *P. subnigra:* 46, section of hymenium showing cystidia (a), and spores (b), × 550; 47, spores, × 1200. All from type specimens.

Habitat: attached to a small buried root.

Distribution: known only from the type locality, Seattle, Wash.

b. Plants 4–15 cm. broad at maturity.
aa. Spores smooth (see also p. 123).

14. **Pholiota ombrophila** Fries, Hym. Eur. 216. 1874.

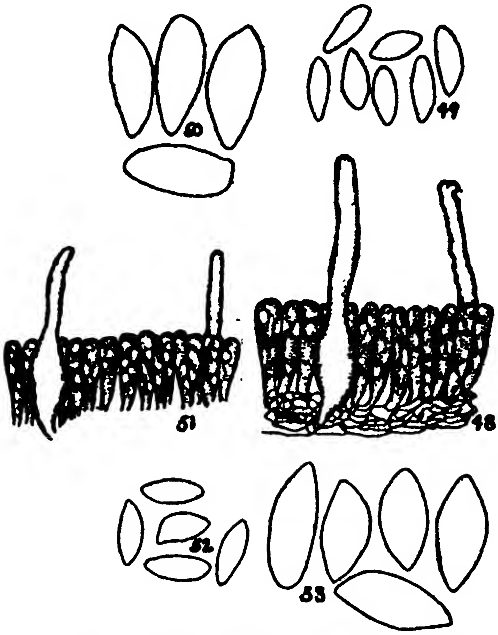
Pileus 3–10 cm. broad, campanulate-convex to nearly plane, dull brown, close to wood-brown or verona-brown, russet or light cinnamon in herbarium specimens, at first with a few white floccose fibers or scales on the margin, soon glabrous, hygrophanous or subviscid when moist; margin even or faintly striate; flesh white or somewhat colored, taste mild, odor none; gills usually decurrent, medium-close or slightly distant, 4–6 mm. broad, clay-color to rusty-brown, the margin white-crenulate in fresh plants; veil forming a median or superior, membranous, broad, conspicuous, often striate, persistent annulus; stem central, equal or

enlarged below, whitish or brownish, often dark below, stuffed or hollow, 4–8 cm. long, 4–15 mm. thick; spores cylindric-elliptic or fusoid-elliptic, smooth, 11–15 × 5–7 μ; cystidia abundant, conspicuous, projecting 20–40 μ, flask-shaped.

Habitat: in grassy places in woods or wooded pastures.

Distribution: specimens have been examined from Oneida, Bronx Park, and Lake Placid, N.Y.; Seattle, Wash.

Illustrations: Fries, Ic. Hym. *pl. 103, f. 2;* Harper, Trans. Wis. Acad. Sci. 17: *pl. 31.*



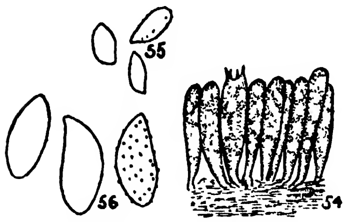
Figs. 48–53. *P. ombrophila:* 48, section of hymenium showing cystidia, × 550; 49, spores, × 550; 50, spores, × 1200. All from specimens at New York from Bresadola. 51, section of hymenium showing cystidia, × 550; 52, spores × 550; 53, spores, × 1200. All from type specimens of *P. washingtonensis.*

This species represents the height of development in a group in which have been described in addition, *P. subnigra* Murrill, *P. aggericola* Peck, *P. indecens* Peck, *P. washingtonensis* Murrill,and *P. erebia* Fries. It cannot be sharply separated from either the first or the last of these and the others must be referred to synonymy. Plants usually retain more of the characteristic umber coloration of the pileus than in *P. erebia,* they are often larger, and the gills are more distinctly decurrent. Sometimes herbarium specimens show the yellowish-brown color usually present in mature dried plants of *P. erebia.* If Harper's spore measurements (8–9 μ long) are correct, his plants cannot belong to this species.

15. Pholiota aurea (Mattuschka) Fries, Syst. Myc. 1: 241. 1821. Pl. 12.

Agaricus aureus Mattuschka, En. Stirp. Sil. Herbor. 351. 1779.

Pileus fleshy, 10–15 cm. broad, convex to plane, often upturned in age, subumbonate, firm, surface dry, pinkish-buff to cinnamon-buff or ochraceous-buff, or the center more cinnamon, covered with a fine but distinct concolorous scurf that may separate into distinct granulose points much as in *Lepiota granulosa;* margin even, thin, appendiculate; flesh thick, compact, yellowish; gills rounded at the base, rather close, 0.7–2 cm. broad, ochraceous-buff to ochraceous-tawny; veil forming a firm, large, pendulous annulus, lemon-color on the upper side, dark buff beneath, eventually disappearing; stem central, tapering upward from an enlarged base, below the annulus granular scurfy as the pileus, above glabrous or nearly so, concolorous or lighter than the pileus, stuffed or solid, 10–18 cm. long, 2–3 cm. thick, inserted 2–5 cm. into the ground; spores ferruginous in mass, golden-brown under the microscope, narrow ovoid to elongate-ovoid, smooth or perhaps sparingly warted in age, 9–12 × 4–6 μ; cystidia none.



Figs. 54–56. *P. aurea:* 54, section of hymenium showing basidia, × 550; 55, spores, × 550; 56, spores, × 1200. All from Overholts Herb. No. 8364.

Habitat: on the ground under bushes.

Distribution: known only from British Columbia.

The specimens on which my record of this species is based are unique in the character of the covering of pileus and stem, having somewhat, though not altogether, the appearance at times of the granulose covering of the stem and pileus of *Lepiota granulosa,* as is emphasized in Ricken's description of this species.

In KOH solution or in glycerine the spores have a strong tendency to cohere in twos and fours. In most cases they are undoubtedly smooth but I have seen a few that seem to be sparingly marked with prominent echinulate points. At best they are unfavorable objects for study in the particular specimens I have examined.

In his emended description of this species Ricken emphasizes the peculiar covering of pileus and stem and the smooth spores as characters separating *P. aurea* from *P. spectabilis.* Also the spores are larger and somewhat different in shape.

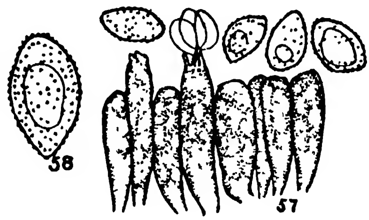
In preparing the paragraph descriptive of this species I have relied largely on the excellent notes sent with the specimens by Mr. W. S. Odell of the Dominion Experimental Farms, Ottawa, Canada.

bb. Spores rough.

16. Pholiota caperata (Pers.) Fries, Syst. Myc. **1**: 241. 1821. Pl. 13.

Agaricus caperatus Persoon, Syn. Fung. 273. 1801.

Pileus 5–15 cm. broad, hemispheric or ovate, then campanulate or convex to nearly plane, ochraceous-buff to ochraceous-tawny, sometimes blackish at the center in dried plants, dry or moist, at first covered with appressed white fibrils that give the pileus a gray appearance and may be more or less arranged in scales, finally more glabrous, especially on the margin, and then likely to be considerably wrinkled or corrugate; margin even, at first incurved; flesh white, taste mild; gills sinuate-adnate or adnate to slightly decurrent, medium-close, 5–15 mm. broad, at first whitish, then clay-color, finally ferruginous, becoming cinnamon in dried plants, usually variegated with close, narrow, light and dark cross-bands and appearing transversely wrinkled, the edge floccose-crenate; veil forming a persistent, superior or almost median, white, deflexed, membranous annulus, sometimes striate on the upper side; stem central, equal, white or slightly yellowish, floccose-tomentose above the annulus, glabrous or slightly fibrillose below, sometimes with a definite annular ring just at the base—the remains of the universal veil—solid, 6–15 cm. long, 7–25 mm. thick; spores broadly and inequilaterally elliptic, echinulate, 11–19 × 7–11 μ; cystidia none.



Figs. 57–58. *P. caperata:* 57, section of hymenium showing basidia and spores, × 550; 58, spores, × 1200. All from Overholts Herb. No. 5241.

Habitat: on the ground in woods.

Distribution: specimens have been examined from Bar Harbor, Me.; Ontario, Canada; Stow, Mass.; Chappaqua, Adirondack Mts., West Ft. Ann, and Gansevoort, N. Y.; Lamar, Stone Valley,

and Reitz Gap, Pa.; also reported from Michigan by Kauffman and by Harper.

Illustration: Bresadola, Fung. Mang. *pl. 48;* Fl. Dan. *pl. 1675;* Gillet, Champ. Fr. *pl. 520 (518)*; Harper, Trans. Wis. Acad. Sci. **17:** *pl. 24;* Hard, Mushrooms, *f. 212;* Peck, Rept. N. Y. State Bot. **54:** *pl. 73, f. 1–5;* Ricken, Blätterp. *pl. 55, f. 2.*

Among the true Pholiotas this species is a characteristic one by reason of the floccose fibers on the young pileus, the bright color, the conspicuous transverse banding on the gills of both fresh and dried plants, and the large, elliptic or lemon-shaped, rough spores. In most instances the so-called volva at the base of the stem is not visible in dried plants, and the genus *Rozites*, to which the species is often referred, is scarcely tenable. The nature of this basal ring is the same here as in certain large species of *Coprinus*, and in the light of recent morphological studies is the remnant of the universal veil in which, to greater or less degree, most fleshy agarics are at first enclosed. The species represents an intermediate condition, therefore, in regard to veil development, between those forms in which a definite volva results, and those in which the enclosing fibers are too scanty to leave such a trace.

P. Mcmurphyi, described from California, probably represents the Pacific Coast form of this species.

In age, plants of this species present an often misleading similarity to *Hypholoma rugocephalum*, in which the pileus colors are almost identical and the spores strikingly similar.

17. Pholiota Mcmurphyi Murrill, Mycologia 4: 260. 1912.

Pileus 4–8 cm. broad, convex to nearly plane, rather thick and fleshy, greenish-yellow at the margin, orange-cinnamon at the center, ochraceous-orange to tawny when dry, slimy-viscid, glabrous; flesh white, without characteristic taste or odor; gills adnate or slightly sinuate, close, soon brownish, 4–8 mm. broad; veil forming an inconspicuous, fibrillose, superior, torn annulus; stem central, equal, yellowish-white, solid, below the annulus rough with several conspicuous ridges, 4–6 cm. long, 1–2 cm. thick; spores ovoid or elliptic, quite rough, 13–17 (–21) × 7–7.5 (–10) μ; cystidia none.

Habitat: on the ground among leaves in oak woods.

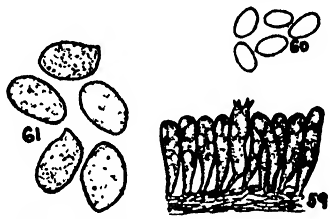
Distribution: known only from the type locality, Searsville Lake, Cal.

This species is close to, if not identical with, *P. caperata*, with which it agrees microscopically. There is present on the gills of dried plants to some extent the peculiar appearance of cross-bands, as characteristic of *P. caperata*, but they are not nearly so well marked and indeed are scarcely noticeable in one of the two mature specimens in the type collection. The peronate stem is different also, and the annulus is of a more delicate texture and more evanescent.

2. Plants with small spores up to 9 μ long.
a. Spores rough-walled (see also p. 126).

18. Pholiota minima Peck, Rept. N. Y. State Mus. **41**: 65. 1888.

Pileus 3–8 mm. broad, hemispheric or campanulate, umbonate, brown when moist, pale buff or yellowish-white when dry, brown in herbarium specimens, hygrophanous, glabrous, margin striatulate when moist; gills adnexed, subdistant, ferruginous, cinnamon in dried plants, 1–2 mm. broad; veil forming an evanescent, median or superior annulus; stem central, equal, concolorous with the pileus, shining, glabrous, solid, 1–2.5 cm. long, 1–2 mm. thick; spores ovoid or elliptic, minutely asperulate, 6–8.5 × 3.5–4.5 μ; cystidia none.



Figs. 59–61. *P. minima:* 59, section of hymenium showing basidia, × 550; 60, spores, × 550; 61, spores, × 1200. All from type specimens.

Habitat: among hair-cap mosses.

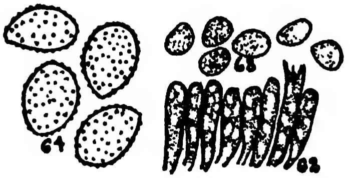
Distribution: specimens have been examined from the Catskill Mts., N. Y.; Auburn, Ala.

The minute roughness of the spores is likely to be unnoticed under the usual 4-mm. objective, but comes out well under the oil-immersion lens.

19. Pholiota trachyspora Clements & Clements, Crypt. Form. Colo. No. 373. 1906.

Pileus 2.5–6 cm. broad, convex or plane, deep golden- or coffee-

brown to dark melleous, entirely covered with matted floccose fibrils of the same color or these collected into squamules particularly at the center of the pileus, dry; gills adnate to adnexed, deep brown, medium-close, 3–6 mm. broad; veil forming a persistent or evanescent, superior annulus; stem central, equal, fibrillose, umber-brown, 4–8 cm. long, 4–10 mm. thick; spores broadly ovoid or subglobose, dark under the microscope, decidedly rough-walled, 7–9 × 5–6 μ; cystidia none.



Figs. 62–64. *P. trachyspora:* 62, section of hymenium showing basidia, × 550; 63, spores, × 550; 64, spores, × 1200. All from type specimens.

Habitat: on the ground in woods.

Distribution: known only from the type locality, Sugar Loaf Park, Colo.

The above description is drawn from the dried specimens as distributed (*l. c.*) by Clements. A collection from Tennessee in the herbarium of the New York Botanical Garden bears strong resemblance to this species, but is not admitted at present. The plants are decidedly dark-colored in the dried state. The subglobose spores are unlike anything else in the genus *Pholiota.* A photograph accompanying the exsiccati specimens shows a well-formed annulus in mature plants. In some respects the plants resemble species of *Cortinarius.*

b. Spores smooth.

aa. Plants 1–3 cm. in diameter; from the Pacific Coast only (see also p. 128).

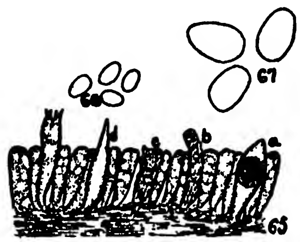
20. Pholiota terrestris Overholts, N. Am. Fl. **10:** 268. 1924.

Pileus 1–3 cm. broad, convex, uniform sayal-brown to cinnamon-brown in dried plants, dry, squamulose with appressed, dark-colored, fibrillose scales or the margin fibrillose only; gills adnate or slightly decurrent, medium-close, 2–4 mm. broad, bright cinnamon; veil ample, membranous, not forming a distinct annulus but sometimes adhering considerably to the margin of the pileus; stem central, equal, pallid above, brown below, the apex floccose, distinctly scaly below the sheathing veil remnants

on the stem, 3–6 cm. long, 2–5 mm. thick; spores oblong-ellipsoid, smooth, 5.5–6.5 × 3.5–4.5 μ; cystidia of several inconspicuous types, none projecting strongly, some brown or with a brown mass within.

Habitat: on a lawn.

Distribution: known only from the type locality, Corvallis, Ore.

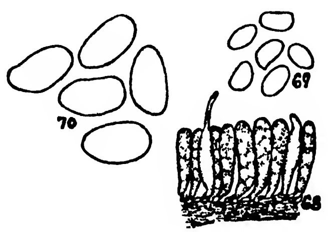


Figs. 65–67. *P. terrestris;* 65, section of hymenium showing basidia and several types of inconspicuous cystidia, × 550; 66, spores, × 550; 67, spores, × 1200. All from type specimens, in New York Botanical Garden Herbarium.

The species approaches *P. angustipes* of the East but the spores are somewhat smaller, the stem more scaly, and the cystidia more conspicuous. These latter organs are typically clavate-fusoid, with a slightly projecting tip and a distinct ball-like content that has a strong affinity for the eosin stain, so that sections left in it for half an hour show these sterile structures extremely well. *P. terrigena* of Europe is similar, but according to specimens from Bresadola has spores 8–9 μ long and entirely lacks cystidia. Harper's plants referred to *P. terrigena* seem to belong here and he gives the smaller spore record of this species.

21. Pholiota anomala Peck, Bul. Torr. Bot. Club **22**: 202. 1895.

Pileus 1.5–2.5 cm. broad, at first hemispheric or sub-conical, then convex, broccoli-brown when moist, pale yellow or cream-color when dry, warm-buff in dried plants, hygrophanous, glabrous; gills adnate or decurrent, medium-close or slightly distant, 3–4 mm. broad, pale, becoming brownish-ferruginous, ochraceous-orange to cinnamon in dried plants; veil forming a slight, finally evanescent, annulus; stem central, equal, fibrillose or glabrous, whitish or brownish, hollow with irregular transverse partitions or the cavities filled with a cottony tomentum, 3–6 cm. long, 2–6 mm. thick; spores oblong-ellipsoid, smooth,



Figs. 68–70. *P. anomala:* 68, section of hymenium with a single narrow cystidium-like body, × 550; 69, spores, × 550; 70, spores, × 1200. All from co-type specimens from the McClatchie Herb. at New York.

very dilutely colored, 7.5–10 × 4–5 μ; cystidia present, or so rare as to pass unnoticed, not conspicuous, clavate and attenuate, sometimes to a long whip-like point that projects 10–15 μ beyond the basidia, 40–50 × 5–7 μ.

Habitat: on sticks and leaves on the ground.

Distribution: known only from Pasadena, Cal.

The type specimens at Albany are in a far better state of preservation than those in a collection from the McClatchie Herbarium at New York. The gills in mature plants are strongly decurrent and the annulus is nearly or quite gone. Sections of the stem show the peculiar-chambered internal structure in good shape. The organs described above as cystidia may prove to be quite different in their origin from true cystidia, and probably their importance should not be stressed. The species has not been recognized since its discovery and its affinities are in doubt.

bb. Mature plants more than 3 cm. in diameter.

22. Pholiota albivelata Murrill, Mycologia 4: 260. 1912.

Pileus 2–6 cm. broad, convex to plane, sometimes somewhat umbonate, isabelline tinted with rose, resembling the color of some species of *Gomphidius*, the umbo slightly darker, honey-yellow to light clay-color in herbarium specimens, slimy-viscid, glabrous; gills adnate or slightly sinuate, ventricose, medium-close or slightly subdistant, becoming fulvous, the edge white-crenate; veil forming a large erect or pendant, superior or median, persistent annulus, pure white on the lower side, the upper side brown from the spores and striate from the gills; stem central, equal, usually heavily white-floccose just below the annulus, pruinose or slightly floccose above, becoming subglabrous and rarely yellowish toward the base, solid or hol-

Figs. 71–73. *P. albivelata:* 71, section of hymenium showing different types of cystidia (a–e), and spores (f), × 550; 72, spores, × 1200; 73, isolated cystidia showing the rounded body near the apex, × 550. All from Overholts Herb. No. 6027.

low, 5–8 cm. long, 4–10 mm. thick; spores ovoid to narrow-ellipsoid, smooth, slightly apiculate at one end, 7.5–9 × 4.5–5.5 μ; cystidia abundant, not projecting conspicuously, small, hyaline with a rounded conspicuous dark-staining body in the apex, sometimes pointed, but more often obtuse, 30–35 × 7.5–9 μ.

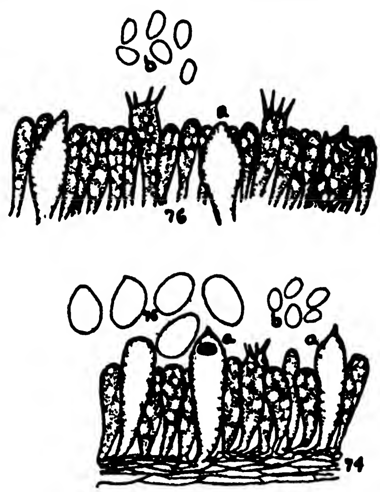
Habitat: on the ground in woods.

Distribution: specimens have been examined from Seattle, Wash.; Salem, Newport, and Glen Brook, Ore.

This species is fairly well represented at New York. The heavy white tomentum on the stem just below the annulus is a marked character in most specimens. The cystidia with their colored contents are different from those of any other species, and while they do not project conspicuously, yet through their abundance they are not likely to be overlooked.

23. **Pholiota duroides** Peck, Bul. N. Y. State Mus. 122: 148. 1908.

Pileus 2.5–9 cm. broad, convex becoming nearly plane, dry or moist but not hygrophanous, creamy-white to ochraceous-buff, chamois, cinnamon-buff or nearly ochraceous-orange, retaining these colors on drying, glabrous or slightly appressed-squamose or with spot-like scales or depressions in the center, margin even; flesh white, taste mild; gills adnexed or sinuate-adnate, sometimes with a decurrent tooth, close, narrow, 2–5 mm. broad, whitish becoming brown or rusty-brown, with a white-crenulate edge, cinnamon-buff or snuff-brown when mature; veil forming a superior, white, membranous, pendant or rolled, subpersistent annulus, often striate on the upper side; stem central, equal or enlarged below, glabrous, or at times fibrillose-scaly below, whitish, stuffed or hollow, 3–10 cm.



Figs. 74–76. *P. duroides:* 74, section of hymenium showing the inconspicuous cystidia (a), and spores (b), × 550; 75, spores, × 1200. All from type specimens. 76, section of hymenium as in 75, × 550. From Overholts Herb. No. 7479.

long, 4–15 mm. thick; spores ellipsoid or ovoid, smooth, 4–6 × 3–4.5 μ; cystidia present, obtuse, not projecting strongly yet rather conspicuous in point of size, often mucronate-tipped, 8–11 μ in diameter.

Habitat: on the ground in waste places, especially in open woods.

Distribution: specimens have been examined from Stony Brook and Easton, Mass.; Redding, Conn.; Mount Vernon, Bronx Park, and Syracuse, N. Y.; Delaware Water Gap and Stone Valley, Pa.; White Post, Mountain Lake, and Blacksburg, Va.; Unaka Springs, Tenn.; St. Louis, Mo.

The species is well represented in the herbarium of the New York Botanical Garden. Many of the collections had been referred to the genus *Stropharia,* due possibly to the peculiar color of the gills. In fact the plant scarcely has the appearance of a *Pholiota,* and dried specimens sometimes resemble thin dried plants of *Russula foetens* or *R. pectinata* in color, though some are distinctly colored, and in one collection from Blacksburg, Va. the color is such a distinct reddish-tan that it is close to ochraceous-orange of Ridgway. The annulus varies considerably but is typically pendant as compared with the cottony roll of the annulus of *P. Johnsoniana.*

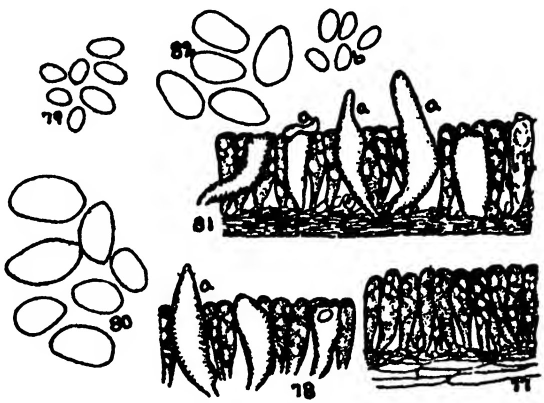
Considerable confusion has resulted from attempts, initiated by Peck, to draw a parallel between this species and *P. dura,* to which it is not closely related. The very narrow gills, between buffy-brown and Dresden-brown in color, and the small spores make this a distinct species. It may be advisable to separate from it the darker-colored forms with pileus with a spotted appearance, but that course seems scarcely justified at present. Harper describes (Trans. Wis. Acad. Sci. **17:** 476. *pl. 25.* 1912) unnamed collections of what are in all probability this species from Wisconsin.

24. Pholiota Johnsoniana (Peck) Atkinson, Mushrooms, 153. 1900.

Agaricus Johnsonianus Peck, Rept. N. Y. State Cab. **23:** 98. 1872.

Pileus 3–10 cm. broad, convex or nearly plane, thick at the

center and thin on the margin, yellowish or ochraceous, or yellow in the center and white on the margin, more or less cinnamon-buff in dried specimens, glabrous or at times with small appressed squamules in the center, dry; margin thin and sometimes striatulate; flesh white, flavor agreeable; gills adnate or sinuate-adnate, close, 2–5 mm. broad, whitish then rusty-brown, snuff-brown to bister in dried specimens; veil forming a thick, white, persistent annulus; stem central, equal, glabrous, light-colored, solid, slightly striate at the top, 7–10 cm. long, 0.8–1.5 cm. thick; spores ovoid or ellipsoid, smooth, 5–8.5 × 3–4 μ; cystidia scarcely noteworthy in some plants and quite conspicuous in others, some imbedded and blunt, others projecting, usually pointed.



Figs. 77–82. *P. Johnsoniana:* 77, section of hymenium showing basidia, × 550; 78, section of hymenium showing inconspicuous cystidium (a), × 550; 79, spores, × 550; 80, spores, × 1200. All from type specimens. 81, section of hymenium with cystidia (a), and spores (b), × 550; 82, spores, × 1200. All from Overholts Herb. No. 3946.

Habitat: on grassy ground in pastures or in leaf mold in woods in late summer.

Distribution: specimens have been examined from Redding, Conn.; Knowersville and Bronx Park, N. Y.; State College, Pa.; also reported from North Carolina by Atkinson and from Michigan by Kauffman.

Illustrations: Atkinson, Mushrooms, *pl. 49 (44), f. 149 (145);* Murrill, Mycologia **7:** *pl. 163, f. 10;* Peck, Rept. N. Y. State Cab. **23:** *pl. 3, f. 4–6.*

Atkinson and Kauffman stress the turbinate shape of the pileus as a character for recognizing the species. In the one collection of fresh plants I have seen this character was not particularly pronounced, and in the type specimens is not evident in their present condition although shown in two of the three illustrations

published by Peck. The species has some of the aspects of *P. praecox*, but has smaller spores, lacks the cystidia of that plant, and the annulus persists as a distinct cottony roll on the stem. The cluster of stellate crystals mentioned by Kauffman as occurring among the basidia are apparent in the type specimens only on the edge of the gills. They are needle-shaped and arranged in a stellate manner. The closest relative of this plant is undoubtedly *P. duroides*, and on the basis of the type material at Albany I have been unable to cite a single distinguishing character. Microscopically they are closely alike. The spores of *P. duroides* are constantly less than 6.5 μ long; those of *P. Johnsoniana* vary between 5 and 8.5 μ and are slightly more irregular in shape. The cystidia of *P. duroides*, types, are not conspicuous but are present as slightly projecting mucronate-tipped organs much larger than the basidia. In *P. Johnsoniana*, types, they are perhaps even less conspicuous. In other collections referable to the one or the other of these two species they are usually more conspicuous than in either of these, and readily distinguishable in crushed preparations of the gills. Some of them do not project and would seem to be the old post-mature basidia.

As interpreted by recent writers, *P. Johnsoniana* does not have quite the appearance of *P. duroides*. The latter most often has the habit of a *Russula* with short and comparatively thick stem, while *P. Johnsoniana* has more the appearance of a slender-stemmed *Agaricus* such as *A. silvicola*. The gills of *P. duroides* are very narrow, while those of *P. Johnsoniana* are considerably broader. The annulus of the latter is a cottony roll on the stem, while that of *P. duroides* is membranous and soon largely evanescent.

B. Growing on wood.

1. Pileus not distinctly scaly (see also 2, p. 142).

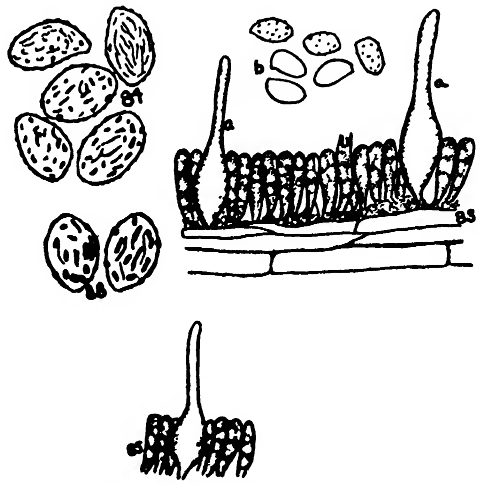
a. Spores rough-walled; prominent flask-shaped cystidia present in the hymenium (fig. 83) (see also b, p. 137).

25. Pholiota marginata (Batsch) Fries, Epicr. Syst. Myc. 169. 1836–38. Pl. 14.

Agaricus marginatus Batsch, Elench. Fung. 65. 1783.

Pileus 1–7(–8) cm. broad, convex to plane or slightly depressed, sometimes somewhat umbilicate, more rarely slightly umbonate,

argus-brown, cinnamon-brown, or Sudan-brown when moist, warm-buff to ochraceous-orange when dry, usually of the latter colors in dried plants, hygrophanous, glabrous; margin usually striatulate when moist, often extending somewhat beyond the gills; context fleshy, thin, concolorous with the pileus, taste and odor farinaceous; gills sinuate-adnate to adnate or slightly decurrent, medium-close to slightly distant, 2–7 mm. broad, light yellowish-brown to buckthorn-brown; veil forming a fugacious or subpersistent annulus; stem central, nearly equal or somewhat swollen just at the apex, fibrillose, pruinose at the top and with a white tomentum at the base, concolorous or lighter than the pileus, hollow, 2–8 cm. long, 2–6 (–10) mm. thick; spores elliptic or ovoid, often smooth when young, with a rough wall when mature, 7–10 × 4.5–6 μ; cystidia present, but usually not abundant, flask-shaped with a long apex that projects 15–25 μ, hyaline, 50–80 × 10–15 μ.



Figs. 83–86. *P. marginata:* 83, section of hymenium showing cystidia (a), and spores (b), × 550 (from Overholts Herb. No. 1562); 84, spores, × 1200; 85, section of hymenium with cystidium, × 550; 86, spores, × 1200. All from type specimens of *P. autumnalis.*

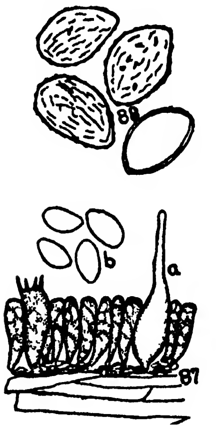
Habitat: on rotting wood, either exposed or buried, of either deciduous or coniferous trees; often on sawdust.

Distribution: specimens have been examined from Natlick, Mass.; Van Cortlandt Park, Ithaca, Karner, and North Greenbush, N. Y.; Auburn, Ala.; State College and Bear Meadows, Pa.; Oxford, Ohio; Falling Springs, Ill.; Creve Coeur Lake, Wicks, Meramec Highlands, and St. Louis, Mo.; Minnesota; Vancouver Island; also reported from Michigan by Kauffman.

Illustrations: Atkinson, Mushrooms, *f. 143* (*147*); Cooke, Ill. Brit. Fungi, *pl. 372* (*403*); Hard, Mushrooms, *f. 215;* Harper, Trans. Wis. Acad. Sci. 17: *pl. 54, 55;* Ricken, Blätterp. *pl. 56, f. 7.*

Under this name I have listed one of our most common species on old logs in woods from spring to fall. It differs from *P. marginella* in the larger, rough spores, and in the presence of cystidia. *P. discolor* differs largely only in the viscid pileus and the brighter colors on drying. I have been at much loss as to how the species may differ from *P. unicolor*, as they seem very closely related if indeed there is a separating character of enough constancy to enable one to distinguish the one from the other. On the Pacific coast there is an apparently common plant which dries a bright color, has a persistent, well-developed, superior membranous annulus, and the spores are less roughened or altogether smooth. Also, the stem is slender, scarcely more than 1–2 mm. thick. This plant I am calling *P. unicolor*. The same type is also found in the East where these characters seem to be less constant but more or less distinguishable. In *P. marginata* the stem is 2–4 mm. or more thick, has an evanescent and fibrillose, rather than membranous, annulus, and dried plants are more often of a dull brown color. I feel that the two are, however, hardly worthy of separate specific rank. This difference is essentially that of Kauffman, I believe, although he admits plants of somewhat larger size to *P. unicolor*.

Agaricus (*Pholiota*) *autumnalis* Peck is a synonym.



Figs. 87–88. *P. unicolor:* 87, section of hymenium showing a cystidium (a), and spores (b), × 550; 88, spores, × 1200. All from specimens at New York, from Washington, collected by Murrill.

26. Pholiota unicolor (Vahl) Fries, Epicr. Syst. Myc. 170. 1836–38.

Agaricus unicolor Vahl, Fl. Dan. 6^{18}: 7. 1792.

Pileus 0.5–2 cm. broad, campanulate to conic-campanulate or somewhat convex, often sharply umbonate, cinnamon-buff to ochraceous-buff or ochraceous-orange, herbarium specimens cinnamon to ochraceous-tawny, glabrous, hygrophanous, margin striate or fluted; flesh thin, somewhat farinaceous to the taste; gills squarely adnate, often becoming somewhat free with the expansion of

the pileus, rather close, sub-triangular in shape, more or less tawny or ferruginous; veil forming a persistent median or superior, upright, funnel-shaped annulus; stem central, equal, yellowish-brown, decidedly floccose-mealy above the annulus, fibrillose below or the base white-tomentose, hollow, 2.5–5 cm. long, 2–4 mm. thick; spores ovoid or elliptic, smooth or slightly rough when mature, 7.5–10 × 5–6 μ; cystidia rare, projecting, flask-shaped, hyaline, pointed.

Habitat: on rotten wood of coniferous or deciduous trees.

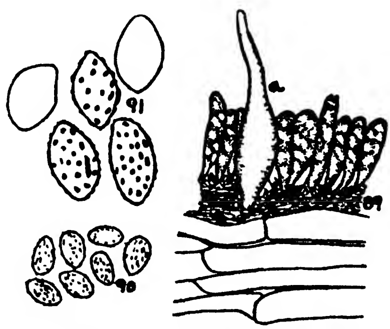
Distribution: specimens have been examined from Piscataquis Co., Me.; Redding, Conn.; Bronx Park and Palisades, N. Y.; Auburn, Ala.; Corvallis and Mill City, Ore.; Seattle, Wash.; Palo Alto, Cal.; also recorded by Kauffman from Michigan.

Illustrations: Bulliard, Herb. Fr. *pl. 530, f. 2* (as *Ag. xylophilus*); Cooke, Ill. Brit. Fungi, *pl. 356* (*404*), *f. b.*

The species is closely related to *P. marginata*, from which the persistent membranous annulus, the less roughened spores, the thinner stem, and the bright colors of dried plants may separate it. See also under *P. marginata*.

27. **Pholiota discolor** Peck, Bul. Buffalo Soc. Nat. Sci. 1: 50. 1873. Pl. 15.

Pileus 1–3 (–5) cm. broad, convex then expanded or slightly depressed, cinnamon-rufous, bright ochraceous-yellow when dry, cinnamon-buff, ochraceous-orange, or cinnamon in dried plants, hygrophanous, smooth, viscid, margin striatulate when moist, even when dry; gills adnate or with a decurrent tooth, medium-close or somewhat distant, 1–3 mm. broad, pallid then pale ferruginous, mikado-brown or russet in dried plants; veil forming a subpersistent, distinct annulus; stem central, terete, equal, pallid, fibrillose-striate, hollow, 2.5–8 cm. long, 1.5–5 mm. thick; spores elliptic, rough,



Figs. 89–91. *P. discolor:* 89, section of hymenium showing a cystidium (a), × 550; 90, spores, × 550; 91, spores × 1200. All from type specimens.

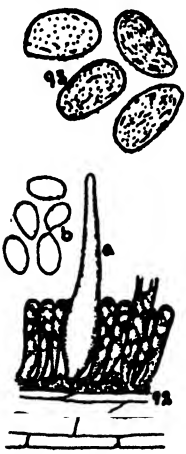
dilute brown under the microscope, 7–9 × 4–6 μ; cystidia present but sometimes rare, projecting 20–40 μ or more, flask-shaped, 40–70 × 10–12 μ.

Habitat: on old logs and on rotten wood.

Distribution: specimens have been examined from Greig and Gansevoort, N. Y.; Edgewater, N. J.; Washington, D. C.; Auburn and Montgomery, Ala.; Creve Coeur and St. Louis, Mo.; also reported from Michigan by Harper and by Kauffman.

Illustrations: Harper, Trans. Wis. Acad. Sci. **17:** *pl. 61B.*

While very closely related to *P. marginata* it seems possible to distinguish *P. discolor* by the viscid pileus and the brighter colors in both fresh and dried plants. Microscopically, the two species are very similar, with spores and cystidia in general the same. Cystidia, however, are quite rare at times and may be difficult to locate but I have never failed to find them. I have noted a tendency for the spores of *P. discolor* to be quite dark in color in sectioned material mounted in KOH—so much so as to give a decidedly darker color to the edge of the basidial layer as seen under the microscope. I am convinced this is an important diagnostic character for this species. Furthermore, this darkening rather effectually obscures the rough character of the spore wall so that spores do not appear so rough-walled as in *P. marginata.* The character of the viscid pileus is confirmed in the notes of several collections, particularly at New York and at St. Louis. *Flammula unicolor* is a quite similar species in the South.



Figs. 92–93. *P. furcata:* 92, section of hymenium showing a cystidium (a), and spores (b), × 550; 93, spores, × 1200. All from type specimens.

28. **Pholiota furcata** Overholts, N. Am. Fl. **10:** 272. 1924.

Pileus 1–3 cm. broad, convex to plane, somewhat gibbous at times, reddish-brown when moist, ochraceous when dry, cinnamon-buff in dried plants, hygrophanous, glabrous; margin even, at first incurved; flesh concolorous, odor none; gills slightly decurrent, close, ochraceous to dull cinnamon, 2–3 mm. broad, con-

spicuously forked and connected by veins so as to appear somewhat poroid; veil forming a superior, distinct but somewhat evanescent annulus; stem central, equal, dark watery-brown, floccose-pruinose above the annulus, white-fibrillose below, solid or spongy, 1.5–2.5 cm. long, 2–3 mm. thick; spores ovoid or ellipsoid, somewhat rough at maturity, 7.5–9.5 × 4.5–6 μ; cystidia present and fairly abundant, hyaline, flask-shaped, ending in a long projecting tip.

Habitat: on old mossy logs.

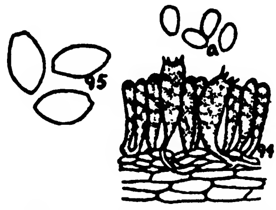
Distribution: known only from Van Cortlandt Park, N. Y. City.

This is the only species of the genus that has forked gills. It may be an anomalous condition that will not be found again, yet the type specimens appear otherwise to be entirely normal. The relationships are with the *P. marginata-discolor* group, as shown by the slightly roughened spores and the flask-shaped cystidia.

b. Spores smooth (see also c, p. 141).

29. Pholiota marginella Peck, Rept. N. Y. State Mus. **51**: 289. 1898.

Pileus 1–4 cm. broad, convex becoming nearly plane, buckthorn-brown or yellowish-red when young or moist, whitish or yellowish-buff when dry, warm-buff or cinnamon-buff in dried plants, hygrophanous or at times subviscid, glabrous; young margin striatulate, slightly silky, with whitish fibrils; gills sinuate-adnexed or sinuate-uncinate, easily separating, medium-close, 1–4 mm. broad, minutely eroded on the edge, whitish becoming dark ferruginous; veil forming a slight or well-developed fugacious annulus; stem central, equal, fibrillose below, pruinose above the annulus, stuffed or hollow, whitish or pallid, sometimes with a white tomentum at the base, 3–10 cm. long, 1–6 mm. thick; spores ellipsoid or ovoid, smooth, slightly truncate at one end, brown, 6–8 (–9) × 3.5–4.5 μ; cystidia none.



Figs. 94–95. *P. marginella:* 94, section of hymenium showing spores (a), × 550; 95, spores, × 1200. All from type specimens.

Habitat: decaying wood or on sawdust piles.

Distribution: specimens have been examined from North Conway, N. H.; North Elba, Bronx Park, and Staten Island, N. Y.; Trenton, N. J.; State College, Bear Meadows, and Stone Valley, Pa.; Oxford, Ohio; Tolland, Colo; Seattle, Wash.; Yakutak Bay, Alaska.

Illustrations: Peck, Rept. N. Y. State Mus. **51:** *pl. B, f. 12–20.*

Though apt to be confused on external appearances with *P. marginata* and *P. discolor* this species is decidedly distinct in the smaller, smooth spores and in the absence of cystidia. It is much more closely related to *P. mutabilis* from which it scarcely differs except in a lack of scaliness on the stem. A favorite haunt for it is an old sawdust pile, and most of the collections examined have been from such a habitat. On drying the pileus is typically much lighter than in *P. marginata* but not so bright as in *P. discolor*. The color is a hue entirely distinct from either of these, and by it alone the species can be recognized. I found it to be the most abundant species in the vicinity of Tolland, Colorado, in 1913 and 1914, and at least a dozen collections are preserved in my herbarium from that locality.

30. Pholiota mutabilis (Schaeff.) Fries, Epicr. Syst. Myc. 169. 1836–38.

Figs. 96–97. ***P. mutabilis:*** **96, section of hymenium with spores (a), × 550; 97, spores, × 1200. All from specimens at New York from Bresadola.**

Agaricus mutabilis Schaeff. Fung. Bavar. 4: Ind. 6. 1774.

Pileus 1.5–3 cm. broad, convex to plane, cinnamon when moist,paler when dry, ochraceous-buff in dried plants, hygrophanous, glabrous; gills adnate or slightly decurrent, medium-close, 2–4 mm. broad, pallid then cinnamon; veil forming a white or dark, superior, evanescent or persistent annulus; stem central, equal, concolorous with the pileus, decidedly scaly below the ring, pruinose above, stuffed then hollow, 3–7 cm. long, 3–5 mm. thick; spores ovoid or elliptic, slightly truncate at one end, smooth, 6–7.5 × 4–5 μ; cystidia none.

Habitat: on stumps and logs.

Distribution: specimens have been examined from Cleveland and Oxford, Ohio; Gunnison River, Colo.

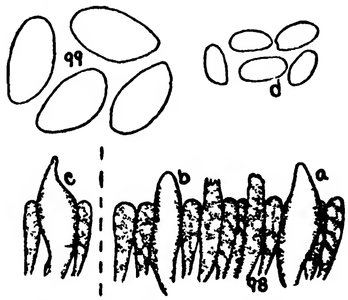
Illustrations: Batsch, Elench. Fung. *pl. 38, f. 208;* Bresadola, Fung. Mang. *pl. 51;* Cooke, Ill. Brit. Fungi, *pl. 355 (402);* Fries, Sverig. Atl. Svamp. *pl. 47;* Lanzi, Fung. Roma, *pl. 76, f. 3;* Schaeffer, Ic. Fung. *pl. 9.*

Apparently the species is much more common in Europe than in America. With us it is quite rare and was reported by neither Harper nor Kauffman. Its external appearance would place it near the *P. marginata* group, among which it is unique in having a distinctly scaly stem, and entirely smooth, slightly truncate and much smaller spores. The stem is scaly with scattered scales up to the annulus, in which character it is distinct from *P. marginella.*

31. Pholiota Aegerita (Brig.) Fries, Epicr. Syst. Myc. 164. 1836–38.

Agaricus Aegerita Brig. Funghi Litogr. Napol. *pl. 1.* 1824.

Pileus 3–13 cm. broad, sub-hemispheric to convex and then expanded, avellaneous to chamois, cinnamon in dried plants, dry, glabrous, rugulose on the margin when young; flesh white, firm; gills adnate or becoming nearly free, sometimes slightly decurrent in lines on the stem, close or medium-close, 4–8 mm. broad, dark brown; veil forming a median-superior, persistent, conspicuous annulus; stem central, nearly equal, brownish, more or less white-fibrillose, solid, 4–15 cm. long, 4–10 mm. thick; spores ovoid or more often elongate-ovoid or elongate-elliptic, smooth, 9–11 × 4.5–6 μ; cystidia present but not conspicuous, projecting somewhat, hyaline, 6–10 μ in diameter, some pointed at the apex.



Figs. 98–99. *P. Aegerita:* 98, section of hymenium showing the inconspicuous cystidia (a–c), and spores (d), × 550; 99, spores, × 1200. All from specimens at New York from Portugal by Bresadola and Torrend.

Habitat: on recently felled trunks or from wounds in deciduous trees.

Distribution: Michigan.

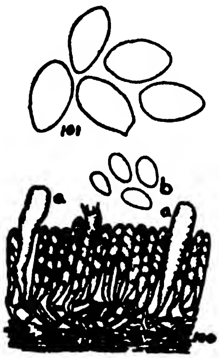
Illustrations: Bresadola, Fungi Mang. *pl. 50;* Briganti, Hist. Fung. Nap. *pl. 32;* Cooke, Ill. Brit. Fung. *pl. 365, 453.*

I have seen no American specimens of this species. It is reported by Kauffman as occurring on debris in low grounds in Michigan. It is a wood-inhabiting form, and specimens at New York from Bresadola and others collected in Europe by Murrill agree quite well with Cooke's illustration which Kauffman says represents aberrant specimens. The colors are similar to *P. praecox* but a deeper tan and the pileus may become areolate, particularly in the variety *strobiloidea.* It was evidently this last character that led Professor Atkinson to concur in designating Harper's plants as this species. It is the only character that his plants have in common with this form of *P. Aegerita,* and the plants are undoubtedly *P. aeruginosa* Peck, which seems to be more common westward.

Only occasionally is the truncate apex of the spore visible to such a marked degree as in *P. Acericola,* but traces of it are occasionally seen. The cystidia seem to present a well-marked characteristic, being rather numerous and projecting only slightly, reminding one of the conditions shown by Dr. Burt for *Stereum ochraceoflavum.*

32. Pholiota oregonense Murrill, Mycologia 4: 262. 1912.

Hypodendrum oregonense Murrill, Mycologia 4: 261. 1912.



Figs. 100–101. *P. oregonense:* 100, section of hymenium showing the inconspicuous cystidia (a), and spores (b), × 550; 101, spores, × 1200. All from type specimens.

Pileus apparently 5 cm. or more broad when mature, convex, obtuse, thick and fleshy, dry, smooth, glabrous, ochraceous-buff to ochraceous-tawny and retaining these colors when dried; margin strongly incurved; flesh thin, cremeous, with an agreeable nutty or amygdaline taste in dried plants; gills adnate, medium-distant to distant, yellow or yellowish-brown, becoming darker, strongly interveined, the edges irregular; veil forming a superior or nearly apical, irregular, yellowish-white annulus; stem central or excen-

tric, terete or compressed, equal or enlarged upward or downward, yellowish above, fulvous below, with small scattered unicolorous subfloccose evanescent scales pointing upward, solid, 6–10 cm. long, 8–20 mm. thick; spores ovoid or elliptic, smooth, 7.5–10 × 3–5 μ; cystidia none or not noteworthy.

Habitat: on decayed spot in trunk of living willow.

Distribution: known only from the type locality, Glen Brook, Ore.

In outward aspects this species is very similar to *P. spectabilis*. There can be no question, however, that the spores in the types are absolutely smooth and frequently more pear-shaped than ovoid. The specimens are not mature, and it is possible but I think not at all probable that the spores may become rough-walled at maturity. The gills are distant as the plants stand, and the roofs of the gill cavities, at least near the stem, are reticulated with rather conspicuous veins. The gills are not so bright-colored as is usual in *P. spectabilis*. Further study alone can decide as to the status of the species.

c. Spores rough-walled; no cystidia in the hymenium.

33. Pholiota cerasina Peck, Bul. Buffalo Soc. Nat. Sci. **1**: 50. 1873.

Plants cespitose, 5–12 cm. broad, convex to plane, cinnamon-color to tawny, perhaps lighter at times, dry or somewhat hygrophanous, glabrous or nearly so; margin even; context fleshy, rather thin, bitter to the taste, with an amygdaline odor that is best noticed in young plants; gills medium-close or slightly distant, sinuate to adnate or slightly decurrent, yellow, becoming cinnamon or ferruginous, finally pruinose from the spores, 5–12 mm. broad; veil present, forming an early evanescent, spore-stained annulus; stem central or more often excentric, equal or enlarged below, concolorous with the pileus, fibrillose, at least at the apex, solid or stuffed, 5–15 cm. long, 5–12 mm. thick; spores elliptic

Figs. 102–103. *P. cerasina:* 102, section of hymenium with spores (a), × 550; 103, spores, × 1200. All from type specimens.

to ovoid, slightly roughened, brown, 6–9 × 4.5–5.5 μ; cystidia none.

Habitat: on dead wood of deciduous trees.

Distribution: specimens have been examined from Bar Harbor, Me.; Smuggler's Notch, Vt.; Sterling and Mexico, N. Y.

The species is scarcely distinct from *P. spectabilis*, and I have admitted it here only on the basis of Peck's contention that the pileus is hygrophanous—an unusual condition for plants of this type. It cannot be considered distinct in the amygdaline taste, as *P. spectabilis* may be either bitter or amygdaline. I have referred here but a very few collections that seem to match the types exactly. Other collections are in Peck's herbarium so referred, but they depart from the original conception of the species in being decidedly fibrillose and I have referred them to *P. spectabilis*. If there is a hygrophanous *Pholiota* with glabrous pileus in this section, the species will stand; otherwise not. Peck reported it as extremely rare.

34. **Pholiota rubecula** Banning, Rept. N. Y. State Mus. 44: 70 (182). 1891.

Pileus 5–6 cm. broad, convex to plane, reddish-brown, dark reddish-brown, or blackish in dried specimens, glabrous, dry; gills adnate or slightly decurrent, 4–6 mm. broad, tawny when dry, rather close; veil not apparent; stem excentric, equal or tapering and rooting at the base, floccose above, glabrous below, solid, 3–6 cm. long, 4–7 mm. thick; spores ovoid or elliptic, 8–9.5 × 4–6 μ, rough when mature; cystidia none.

Habitat: old stumps and trees.

Distribution: known only from the type locality, Baltimore, Md.

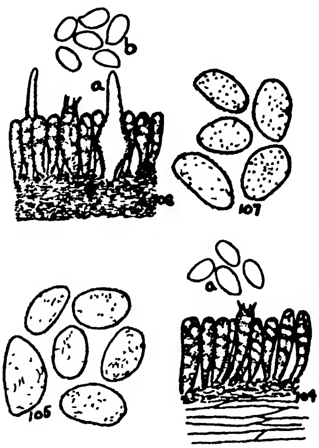
This species has not been recognized since its original publication by Peck. The types still exist at Albany. There are two specimens accompanied by a water-color sketch by Miss Banning. The sketch shows a pileus orange-cinnamon, ochre-red, or tawny, and gills and stem similar but lighter. The color is about that of the pileus of *Lactarius lactifluus*. The specimens show no trace of veil or annulus. The rough spores ally it with the *P. spectabilis* group, among which its affinities are in doubt.

2. *Pileus distinctly scaly at maturity.*

a. Spores rough-walled (see also b, p. 148).

35. Pholiota luteofolia Peck, Rept. N. Y. State Mus. **27**: 94. 1875.

Pileus 2–6 cm. broad, convex, very young specimens dark red or reddish-brown, becoming pinkish-red or yellowish-red when mature, ochraceous-buff or ochraceous-tawny in dried plants, dry, appressed fibrillose-squamulose and sometimes areolate in the center, fibrillose on the margin; context fleshy, thin, typically lavender in fresh plants, bitter; gills adnate or uncinate, sometimes becoming sinuate-adnate, medium-close or somewhat distant, 3–8 mm. broad, yellow becoming bright ferruginous, mostly ochraceous-buff or ochraceous-orange in dried specimens; veil forming a slight, fugacious, spore-stained annulus; stem central or somewhat excentric, equal or enlarged downward, concolorous with the pileus, fibrillose, solid, 3–9 cm. long, 3–10 mm. thick; spores ellipsoid to elliptic, slightly rough, 6–9.5 × 3.5–4.5 µ; cystidia none or not noteworthy.



Figs. 104–107. *P. luteofolia:* 104, section of hymenium with spores (a), × 550; 105, spores, × 1200. All from Overholts Herb. No. 3741. 106, section of hymenium, showing cystidium (a), and spores (b), × 550; 107, spores, × 1200. All from type specimens.

Habitat: dead wood of deciduous trees.

Distribution: specimens have been examined from Forestburgh, West Ft. Ann, and Bronx Park, N. Y.; West Elkton, Ohio; Pacific, St. Louis, and Creve Coeur Lake, Mo.; also reported from Michigan by Kauffman and from Illinois by Harper.

Illustrations: Harper, Trans. Wis. Acad. Sci. **17**: *pl. 48*.

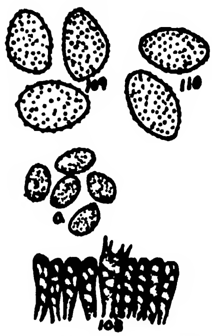
This species is most closely related to *P. aeruginosa*, and further studies may result in rearranging the dividing line between the two species, as some of the collections of the former species examined are without notes concerning salient characters necessary in the identification of dried plants. *P. luteofolia* seems always to lack the green hue of *P. aeruginosa* and does not become so rimose-areolate and the scales appear to be more innate. It is a smaller plant than *P. spectabilis*, and the gills are much brighter-

colored in dried plants. From *P. cerasina* it differs in the distinctly squamulose pileus. The color of mature plants is typically a pinkish-red of about the color of *Lepiota rubrotincta*, but may fade to more pallid or change to yellowish-red in age. Young specimens are darker in color.

36. **Pholiota spectabilis** Fries, Elench. Fung. 28. 1828.

Pl. 16, 17.

Pileus 4–15 cm. broad, convex becoming nearly plane, buff-yellow to apricot-orange or zinc-orange, becoming at times slightly more brownish (tawny) in dried plants, dry or moist, finely silky or in some very young plants practically glabrous at times, to distinctly fibrillose or rivulose or in mature plants squamulose; margin even; context yellow, taste bitter or amygdaline; gills adnexed to adnate or with decurrent teeth or lines, medium-close, 3–8 mm. broad, yellow becoming ferruginous, yellow-ochre to ochraceous-orange or tawny in dried specimens; veil forming a distinct, superior or apical, spore-stained, persistent or subpersistent annulus, sometimes striate on the upper side; stem central or nearly so, nearly equal to decidedly ventricose or bulbous-enlarged at the base, yellow or tawny, yellow and floccose above the annulus, fibrillose or furfuraceous below, 3–15 cm. long, 0.5–3 cm. thick, solid; spores elliptic, rough, 7–9 × 4.5–6 μ; cystidia none.



Figs. 108–110. *P. spectabilis:* 108, section of hymenium with spores (a), × 550; 109, spores, × 1200. All from type specimens of *P. lutea.* 110, spores, × 1200. From specimen at New York from Bresadola from Holland.

Habitat: on stumps and trunks of deciduous or rarely coniferous trees, or growing from buried wood.

Distribution: specimens have been examined from Toronto, Canada; St. Andrews, New Brunswick; Newfane, Vt.; Pittsfield, Mass.; Monmouth Co., Paterson, and Forked River, N. J.; Frederick, Md.; Washington, D. C.; Montgomery and Birmingham, Ala.; Claryville, Mexico, West Albany, Bronx Park, and Floodwood, N. Y.; St. Louis and Creve Coeur Lake, Mo.;

Berkeley, Cal.; Corvallis, Ore.; Seattle, Wash.; also reported by Kauffman from Michigan.

Illustrations: Bernard, Champ. Roch. *pl. 55, f. 1;* Cooke, Ill. Brit. Fung. *pl. 352* (*394*); Fries, Ic. Hym. *pl. 102;* Gillet, Champ. Fr. *pl. 527* (*529*); Harper, Trans. Wis. Acad. Sci. **17:** *pl. 44, 50;* Kauffman, Agar. Mich. *pl. 61;* Murrill, Mycologia **1:** *pl. 7, f. 4.*

As here admitted, the species is characterized by the usually cespitose habit, the uniform buff-yellow color of pileus and stem, the appressed and usually minute fibrils or fibrillose squamules covering the entire pileus at maturity, the subpersistent, nearly apical annulus, and the rough spores 7.5–9 μ long. I have seen but a single collection in which the young pileus is practically or entirely glabrous, and older specimens in the same collection show the fibrils quite distinctly. In other collections the squamules are large enough to be readily visible to the unaided eye. In every collection examined the annulus has persisted in one or more mature specimens and frequently is well developed. The color of the gills is fairly bright but not quite so bright as in *P. aeruginosa* or *Flammula pulchrifolia.*

In some collections, involving dried plants, I get a distinctly amygdaline taste to the context, although Peck records a bitter taste and Ricken says it is bitter (brennend-bitter) in European plants. In one young collection of dried plants I have obtained a distinctly unpleasant bitter taste from the somewhat worm-eaten context, although the specimens are certainly of the same species as other collections in which the taste is amygdaline. Plants of still other collections are practically tasteless. Most curious of all, in one collection sent from Alabama and described as having an "intensely bitter" taste in the fresh plants I am able to detect an extremely pleasant amygdaline taste in the dried plants.

Nearly always the plants are found around old stumps or in similar situations where buried wood is present, to which they are probably always attached, although this point needs investigation.

That *P. lutea* Peck is in reality this species I think there can be no question, after studying the abundant collections at New York, the European literature, and such European specimens as

are available. As it usually occurs in this country, *P. lutea* is less robust than the European plant. If we take Fries' illustration of this plant as typical of the European species, then our plants mostly differ in not having quite as conspicuous squamules as there shown, even in our most squamulose specimens. I believe, however, that there is no other European illustration that shows so squamulose a pileus as does Fries'. Cooke's illustration (pl. 352) approaches it most closely but here the pileus is shown with appressed rivulose squamules formed by the separation of the long fibers of the cuticle. This type is represented in America, at least on the Pacific Coast. One collection at New York from Berkeley, Cal., 1912, shows this condition almost exactly. In the same category belongs the type collection of *P. ventricosa* Earle, also described from California, but here the plants are not mature enough to illustrate the character as well as in the other California collection. It is also worthy of note that this last collection has stems that are taper-pointed at the base as shown for example in Gillet (Champ. Fr. *pl. 529*), although the other collection agrees with Fries' figure and Cooke's illustration in being obtuse or enlarged at the base. All of these are quite robust and must be considered to be the best-developed type of *P. spectabilis*. But there occurs also, on both our eastern and our western coasts, plants (the collections show only young specimens) in which the stem is fully robust enough to be listed as rather typical *P. spectabilis*, with the obtuse or enlarged stem base. These have uniformly, however, the pileus surface of our typical eastern *P. lutea*. I refer here to specimens at New York from Seattle, Wash., by Parker in 1891, and particularly to a collection from Vermont by Burlingham in 1906. From this condition, the transition to the typical *P. lutea* is easy, where the stem is scarcely bulbous at the base, the plants are medium in stature, and the pileus varies from slightly fibrillose to squamulose.

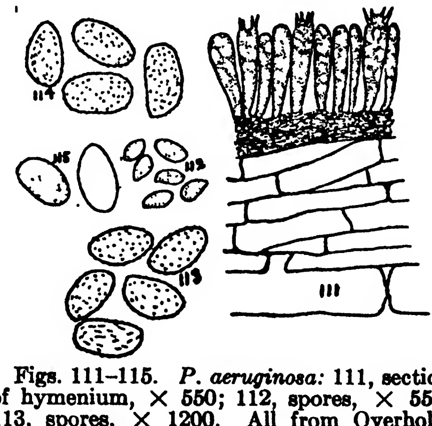
The question may well be asked, "Does the typical *P. lutea* occur as such in Europe?" The answer must be in the affirmative, on the basis of an illustration of *P. spectabilis* published by Bernard in Champ. Rochelle, *pl. 55, f. 1*, where our plant is quite well shown. If Peck had based his species on the types of plants illustrated in this reference and represented by one collection at

New York from Alabama by Earle, another from Bronx Park by Murrill in 1911, and two or three others, there would be more basis for keeping it distinct. For this type represents one extreme of development, the California specimens the other, and *P. lutea* as described by Peck is intermediate between the two. Moreover, specimens of *P. spectabilis* at New York from Bresadola show scarcely a trace of fibrils on the pileus and in stature compare well with our plants. There is a specimen at Albany, from New Brunswick, on birch, that nearly exactly matches Bresadola's specimens.

I must conclude, therefore, that *P. spectabilis* in Europe and America is about equally variable, ranging from medium-sized plants with cylindric or enlarged stems and nearly glabrous to fibrillose-squamulose pileus, to large robust forms with ventricose stems and pileus most often heavily fibrillose and becoming rivulose but sometimes only slightly fibrillose.

37. **Pholiota aeruginosa** Peck, Rept. N. Y. State Mus. 43: 35 (81). 1890. Pl. 18.

Pileus 2–10 cm. broad, convex, greenish becoming tinged with yellow or brown, drab to cinnamon or ochraceous-buff in dried specimens, dry, at first glabrous, usually soon more or less areolate with each areola surmounted by one to three fibrillose scales, or sometimes completely squamulose without areolae; flesh with a green tinge, yellowish in dried plants; gills adnate or sinuate-adnate, easily separating, 3–7 mm. broad, pale-ochraceous when young, becoming ochraceous-orange or apricot-buff on drying; veil leaving only a slight fibrous, lacerated annulus, or entirely evanescent; stem central or excentric, equal



Figs. 111–115. *P. aeruginosa:* 111, section of hymenium, × 550; 112, spores, × 550; 113, spores, × 1200. All from Overholts Herb. No. 8081. 114, spores, × 1200 (from type specimens); 115, spores, × 1200 (from Overholts Herb. No. 8773, spores probably less mature).

or nearly so, glabrous or slightly fibrillose, sometimes sulcate-striate, colored like the pileus, solid, 3–8 cm. long, 4–10 mm. thick; spores ellipsoid or elliptic, rarely entirely smooth, typically slightly echinulate when mature, 6–8 × 3.5–4.5 μ; cystidia none.

Habitat: on decaying wood, probably mostly of coniferous trees.

Distribution: specimens have been examined from Trexlertown and Aaronsburg, Pa.; Staten Island, and West Ft. Ann, N. Y.; Womble, Ark.; Priest River, Idaho; Seattle, Wash.

In Peck's herbarium this species is represented by the type specimen from Pennsylvania and a collection from West Ft. Ann., New York. Another Pennsylvania collection is at New York City, by McIlvaine. Dr. Murrill has already referred his *Flammula viridans* from the Pacific Coast to this species. The species seems to be more common westward and exhibits more variation, even in the same collection, as regards scaliness and the areolae on the pileus. The plants described by Harper on Atkinson's determination as *P. Aegerita* belong here, I judge. *Pholiota Aegerita* of Europe is entirely dissimilar in every respect except the areolate pileus. Excellent specimens of that species are at New York collected by Murrill in Europe.

It is difficult to separate this species in most aspects from *Flammula pulchrifolia*, and the writer is of the opinion that they may represent the same plants.

The markings on the spore walls are discernible only under close scrutiny with the high power, but are very evident under the oil-immersion lens, in all but one collection I have examined. In that one they are mostly smooth even with the higher magnification, but a few are distinctly though sparingly roughened (fig. 115).

Pholiota luteofolia is closely related but the present species seems distinct in the green tints of young plants, the areolate pileus of mature ones, and in the more fibrillose scales.

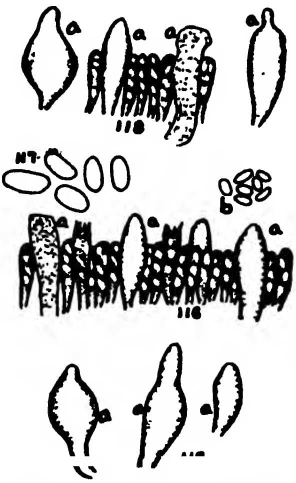
b. Spores smooth.

1. Spores 3.5–5.5 μ long (see also 2, p. 149).

38. Pholiota flammans (Batsch) Fries, Syst. Myc. 1: 244. 1821. Pl. 19.

Agaricus flammans Batsch, Elench. Fung. 30. 1783.

Pileus 2–5 (–8) cm. broad, convex to plane, sometimes umbonate, lemon-yellow or tawny-yellow, zinc-orange or tawny in dried plants, dry, adorned with yellow, superficial, floccose-fibrillose scales that may in large part disappear with age; flesh thin, yellow; gills adnate or very slightly uncinate, medium-close, 2–5 mm. broad, yellow or ferruginous, snuff-brown in dried plants or young specimens may retain their yellow color; veil lemon-yellow, fugacious; stem central, equal, with yellow, recurved, floccose scales, or scarcely more than densely yellow-floccose up to the annulus, stuffed or hollow, yellow, 2–7 cm. long, 2–5 mm. thick; spores oblong, smooth, 3–5.5 × 2–3 μ; cystidia abundant, flask-shaped or clavate-fusoid, brown or hyaline, projecting slightly, 30–40 × 6–12 μ.



Figs. 116–119. *P. flammans:* 116, section of hymenium showing cystidia (a), and spores (b), × 550; 117, spores, × 1200; 118, section of hymenium showing cystidia, and two cystidia isolated, × 550; 119, isolated cystidia, the one on the right hyaline, the other two brown, × 550. All from Overholts Herb. No. 3753.

Habitat: on dead wood of both deciduous and coniferous trees.

Distribution: specimens have been examined from Lake Placid, Osceola, Greig, and Fourth Lake (Herkimer Co.), N. Y.; Glen Brook, Ore.; also reported from Michigan by Kauffman and by Harper.

Illustrations: Fries, Ic. Hym. *pl. 104, f. 1;* Cooke, Ill. Brit. Fungi, *pl. 396* (*368*); Harper, Trans. Wis. Acad. Sci. **17:** *pl. 41C;* Ricken, Blätterpilze, *pl. 55, f. 5.*

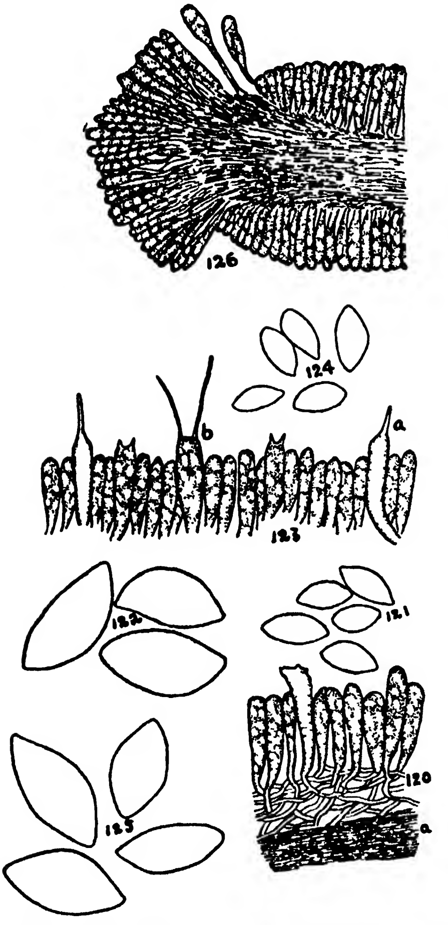
In one collection at New York, from a birch stump, the collector's notes say "viscid."

P. flammans is distinct from all related species in the very small, oblong spores, measuring 3–5 μ long. It is indeed a well-marked species with bright colors and soft floccose scales, and while generally considered as occurring only on coniferous wood, yet a collection at New York is very evidently on the wood of birch. The species is rare, and I have seen no American specimens more than 4 cm. broad.

2. Spores between 9.5 and 15 μ long (see also 3, p. 152).

39. Pholiota albocrenulata Peck, Bul. Buffalo Soc. Nat. Sci. **1:** 49. 1873. Pl. 19.

Pileus 2.5–12 cm. broad, conic-campanulate to broadly convex or nearly plane, sometimes umbonate, uniformly yellowish-brown to sayal-brown or tawny, the darker of these colors in dried plants, quite viscid, with rather large scales that are appressed and sub-gelatinous when wet, but become suberect, floccose, and lighter in color on drying, easily separable and sometimes disappearing in old plants; gills sinuate-adnate or slightly decurrent, medium-close or in large specimens rather distant, 3–13 mm. broad, grayish becoming ferruginous, the edge distinctly white-crenulate and remaining so at least in part in dried plants; veil forming a torn fugacious annulus or partly appendiculate to the margin of the pileus; stem central, equal or somewhat enlarged below, sparingly or abundantly squamose with fibrillose scales up to the annulus, pallid or brown below, white and furfuraceous at the apex, 5–11 cm. long, 0.5–2.5 cm. thick; spores broadly-elliptic or fusoid-elliptic, smooth, brown, 11–14 × 6–8 μ; cystidia apparent in fresh specimens as occasional clavate projecting hyaline



Figs. 120–126. *P. albocrenulata:* 120, section of hymenium showing central medulla (a), × 550; 121, spores, × 550; 122, spores, × 1200. All from type specimens. 123, section of hymenium showing the occasional pointed cystidia, × 550; 124, spores, × 550; 125, spores, × 1200; 126, section of edge of gill showing the clavate cells that give to the edge the crenulate appearance, × 550. All from Overholts Herb. No. 9368.

bodies with one or rarely two long slender apical points, rather difficult to locate in sections of dried plants.

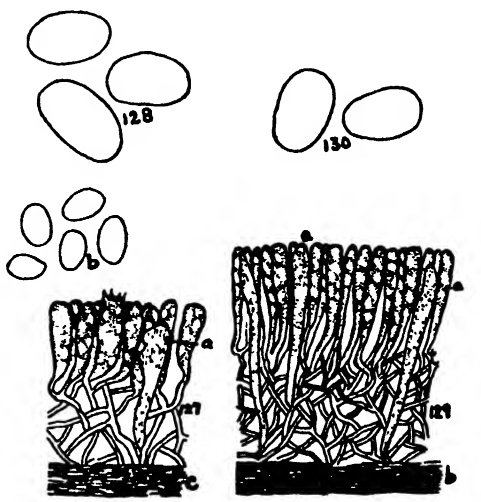
Habitat: at base of trees or on prostrate trunks, especially of sugar-maple; one collection said to have been from a hemlock stump.

Distribution: specimens have been examined from Hebron, N. H.; Adirondack Mts. and Lake Pleasant, N. Y.; Cadillac, Mich.; Unaka Springs, Tenn.; Bear Meadows, Center Co., Pa.

Illustrations: Harper, Trans. Wis. Acad. Sci. **17:** *pl. 42, 43.*

The dark color of the dried pileus recalls *P. aurivella* and the general appearance is similar to that of the European *P. subsquarrosa.* From both of these the species is amply distinct in the large fusoid-elliptic spores. In fact no other similar species of this section, except *P. aurivelloides,* has spores at all comparable in size to these, and in that species they are quite different in shape. The plants usually occur singly. The white crenulations on the edges of the gills are due to the presence there of tufts of radiating clavate cells as shown in my illustration.

In most collections of this species the plants are slender and small in stature, rarely more than 7 cm. broad. Professor Harper illustrates, and I have also found, a large form with pileus 10–12 cm. broad, but otherwise with the characteristics of Peck's types.



Figs. 127–130. *P. aurivelloides:* 127, section of hymenium showing an imbedded cystidium (a), spores (b), and central medulla (c), × 550; 128, spores, × 1200. All from type specimens. 129, section of hymenium showing imbedded cystidia (a), and central medulla (b), × 550; 130, spores, × 1200. All from specimens in New York State Museum, from New Mexico, by Cockerell.

40. Pholiota aurivelloides Overholts, sp. nov.

Pileus 5–8 cm. broad, hemispheric or broadly campanulate to convex, ferruginous to tawny, lighter-colored on the margin, sometimes carob-brown in dried plants,

probably viscid, with a few scattered, spot-like or appressed scales; flesh yellow, rather thick; gills sinuate-adnate or with a decurrent tooth, medium-close or slightly distant, 7–12 mm. broad, whitish then ochraceous-tawny or russet; veil forming a thin, superior, persistent or somewhat evanescent, floccose or submembranous annulus; stem central, equal, yellowish or brownish, more or less scaly, the scales sometimes somewhat gelatinous, solid, 4–8 cm. long, 5–10 mm. thick; spores oblong-ellipsoid, smooth, deep-brown, 9–11 × 6 μ; cystidia numerous or rare, brown, not projecting, 25–35 × 6–8 μ.

Habitat: on dead trees or from wounds in living *Alnus*, *Salix*, or *Betula*.

Distribution: specimens have been examined from Ohio Creek, Colo.; Pecos, N. Mex.; Copperton, Wyo.

The name here used was applied by Peck in his herbarium to the Ohio Creek collection made by Bartholomew, Aug. 24, 1899, and here used as the type collection. It seems sufficiently distinct from *P. aurivella* in the very broad gills and the larger spores that are of a much darker color and with a heavier wall. Their shape is broadly oblong-ellipsoid, while those of *P. aurivella* are narrowly oblong-ellipsoid or ellipsoid. The brown sterile organs in the hymenium are of a somewhat different type also. I have tried to consider these plants as *P. aurivella* but they seem quite different from the plants, various as they are, that have passed under that name.

3. Spores 6–9 μ or rarely longer.

aa. Cystidia present and rather conspicuous as brown or hyaline, imbedded or projecting organs (see also bb, p. 159).

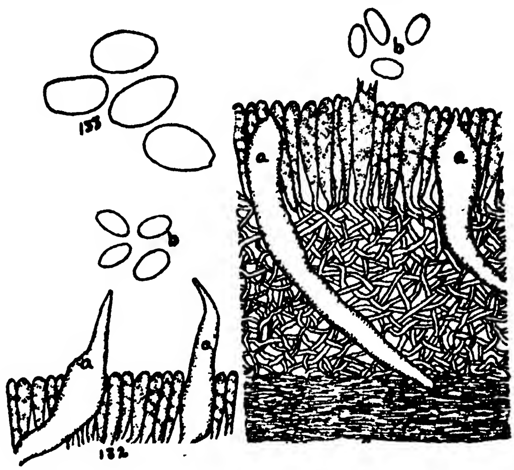
aaa. Pileus viscid (see also bbb, p. 156).

41. Pholiota aurivella (Batsch) Fries, Syst. Myc. **1**: 242. 1821. Pl. 24.

Agaricus aurivellus Batsch, Elench. Fung. *f. 115.* 1783.

Pileus 4–13 cm. broad, campanulate to convex, often broadly umbonate, when young more or less uniformly ochraceous-orange to tawny, when mature becoming more uniformly tawny, at first covered with large appressed spot-like scales which may in large part disappear and when wet may become more or less gelatinous, viscid; flesh yellow; gills sinuate-adnate or adnate, close, dark

rusty-brown when mature; veil forming a superior, torn, spore-stained, partly evanescent annulus; stem central or excentric, equal or tapering upward, dry, yellowish or yellowish-brown, floccose above the annulus, fibrillose below and increasingly scaly or shreddy downwards with fibrillose scales that may become recurved, solid, 5–8 cm. long, 5–15 mm. thick; spores exactly and constantly oblong-ellipsoid, smooth, 7–9.5 × 4–5 μ; cystidia present, often rather rare, brown, sometimes projecting and rather conspicuously sharp-pointed, sometimes imbedded and blunt, 6–8 μ in diameter.



Figs. 131–133. *P. aurivella:* 131, section of hymenium showing the imbedded cystidia (a), spores (b), and central medulla (c), × 550; 132, section of hymenium from another gill showing projecting cystidia (a), and spores (b), × 550. All from specimens at New York from Colorado, by Bethel. 133, spores, × 1200, from specimen at New York from Italy by Bresadola.

Habitat: on trunks of living (rarely dead) deciduous or coniferous trees.

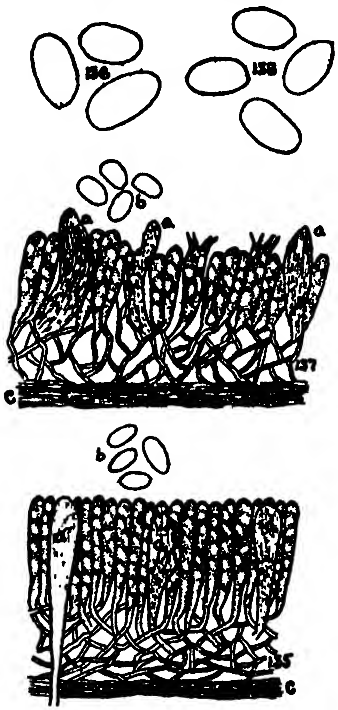
Distribution: specimens have been examined from Colorado; Corvallis, Oregon; San Francisco, Cal.; also reported by Harper from River Forest, Ill.

Illustrations: Batsch, Elench. Fung. *pl. 22, f. 114, 115;* Cooke, Ill. Brit. Fungi, *pl. 390 (351)*; Harper, Trans. Wis. Acad. Sci. **17:** *pl. 38, 39.*

For the distinguishing characters of this species as contrasted with *P. adiposa* see the notes under the latter. The sterile organs in the hymenium of plants referred to this species present wide variations as will be seen from the drawings. In specimens at New York from Bresadola there is an occasional lance-shaped colored organ with much resemblance to the setae of some fungi. In but one American collection have I seen these present—that collected by Gilbert in Oregon, on willow, in 1915. The col-

lection is preserved at New York. Here these seta-like bodies are quite numerous and conspicuous as shown in the illustration. Other collections show a more inconspicuous type of sterile organ and always entirely imbedded. Such collections may represent the type of another species but can scarcely be *P. adiposa*, the most closely related species. The species as here described is admittedly unsatisfactory and consists of collections somewhat similar to *P. adiposa* but yet certainly distinct from it and the next species. Harper's photograph is of particular excellence.

42. Pholiota adiposa Fries, Syst. Myc. 1: 242. 1821. Pl. 20, 21.



Figs. 135–138. *P. adiposa:* 135, section of hymenium showing the imbedded cystidia (a), spores (b), and central medulla (c), × 550; 136, spores, × 1200. All from Overholts Herb. No. 6191. 137, section of hymenium showing cystidia (a), spores (b), and central medulla (c), × 550; 138, spores, × 1200. All from Overholts Herb. No. 6042

Pileus 3–16 cm. broad, hemispheric to convex or plane, antimony-yellow to zinc-orange or finally the center somewhat tawny, decorated with rather medium-sized squamules of a darker color than the rest of the pileus, and drying down to small dark spots on a tawny base, large thick specimens sometimes areolate in dry weather, in wet weather the pileus occasionally glabrous, all colors well retained in dried plants, viscid or glutinous or dry in dry weather; flesh thin or rather thick, white or light yellow, taste not marked; gills adnate or sinuate-adnate, rather close, 4–10 mm. broad, grayish-brown then yellow or rusty-brown, honey-yellow to tawny in dried specimens; veil yellow, forming a slight, floccose, evanescent annulus; stem central or excentric, terete, equal or nearly so, viscid (dry in dry weather), yellow or tawny, with few or many erect or somewhat recurved yellow or tawny scales, or sometimes only fibrillose, solid or stuffed, rarely

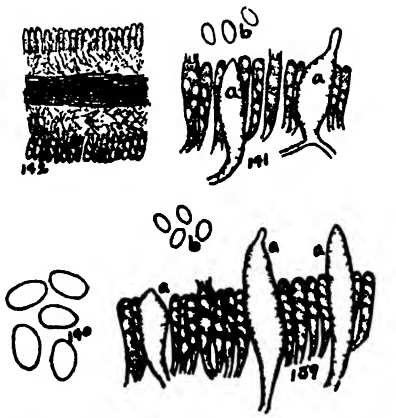
with a small hollow, 4–12 cm. long, 5–20 mm. thick; spores ellipsoid or oblong-ellipsoid, smooth, 7–9(–11) × 4–5 μ; cystidia present, not conspicuous, projecting only slightly if at all, dark brown, clavate, 20–42 × 5–10 μ.

Habitat: stumps and trunks of deciduous trees.

Distribution: specimens have been examined from Cambridge, Mass.; Lake Placid, Bronx Park, and Wells, N. Y.; Forked River, N. J.; State College, Musser Gap, Bear Meadows, and Westport, Pa.; Greencastle and Putnam Co., Ind.; Edgmont and Falling Springs, Ill.; Oxford, Ohio; St. Louis, Mo.; Fort Dodge, Iowa; Plumas Co., Cal.; and Seattle, Wash.

Illustrations: Atkinson, Mushrooms, *pl. 47 (43)*; Berkeley, Outl. Brit. Fungi, *pl. 8, f. 2;* Cooke, Ill. Brit. Fungi, *pl. 395* (*353*); Hard, Mushrooms, *f. 211;* Mycologia **1:** *pl. 7, f. 1–2.* 1909; Peck, Rept. N. Y. State Bot. **49:** *pl. 46.*

The pileus in both fresh and dried condition is typically golden-yellow or lemon-yellow as contrasted with the prevailing tawny or rusty color of *P. aurivella,* its closest relative. The latter species has larger and more spot-like scales and the stem is short and thick and increasingly scaly downward, while in *P. adiposa* the stem is equally scaly up to the ring or increasingly from the base upward. Ricken states that the stem of *P. aurivella* is not viscid as it is in *P. adiposa.*



Figs. 139–142. *P. squarrosoides:* 139, section of hymenium showing cystidia (a), and spores (b), × 550; 140, spores, × 1200. All from Overholts Herb. No. 3770. 141, section of hymenium showing cystidia (a), and spores (b), × 550; 142, section of hymenium showing central medulla tissue, × 550. All from type specimens.

43. **Pholiota squarrosoides** Peck, Rept. N. Y. State Mus. **31:** 33. 1879. Pl. 22.

Pileus 2.5–10 cm. broad, subglobose to convex or nearly plane, light-colored, typically cinnamon-buff or cinnamon in dried plants, viscid, covered with erect, pointed, cinnamon or tawny scales that give color to the pileus, sometimes disappearing on the

margin; flesh white or slightly yellowish, gills sinuate-adnate, medium-close, 4–7 mm. broad, whitish becoming brownish-ferruginous, cinnamon or ochraceous-tawny in dried plants; veil forming a floccose, persistent or evanescent annulus; stem central, equal, brownish and with recurved light cinnamon or tawny scales below the annulus, white and smooth above, solid or stuffed, 5–15 cm. long, 5–12 mm. thick; spores ellipsoid or oblong-ellipsoid, smooth, 4–6 × 3–4 μ; cystidia present, variable, of two general types: (a) hyaline, pointed at the apex, projecting slightly, and (b) brown, obtuse or pointed, sometimes projecting, both types measuring 25–35 × 8–12 μ.

Habitat: on stumps and trunks of deciduous trees.

Distribution: specimens have been examined from Maine; Redding, Conn.; Vaughns, Catskill Mts., Canandaigua, and North Elba, N. Y.; Bear Meadows, Pa.; also reported from Michigan by Harper and by Kauffman.

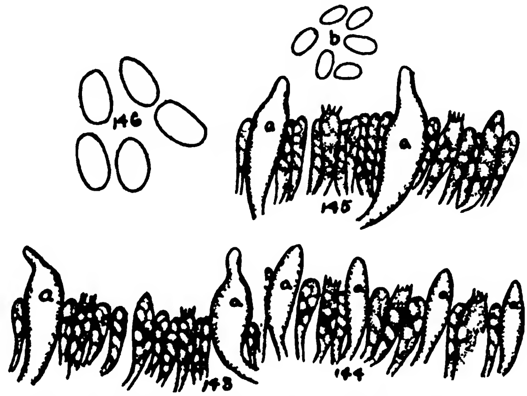
Illustrations: Hard, Mushrooms, *f. 216;* Harper, Trans. Wis. Acad. Sci. **17:** *pl. 36, 37;* Peck, Ann. Rept. N. Y. State Mus. **54:** *pl. 73, f. 6–14;* White, Hymen. Conn. *pl. 21.*

The scales on the pileus appear floccose under a lens, but they are rather harsh to the touch in dried plants. In young plants they appear more or less erect, particularly over the center of the pileus, but on the margin they may be only recurved or in dried plants practically appressed. From *P. squarrosa* the species differs in the viscid pileus, the smaller size, the more cespitose habit, the squarrose center of the more highly scaly pileus, and the smaller spores. The spore difference seems insignificant as here stated but when spores of the two species are compared side by side under the microscope it is very striking. Only rarely do the spores of *P. squarrosoides* reach a length of 6 μ, the wall is thin, and the shape more apt to be broadly ellipsoid, while in *P. squarrosa,* 6 μ is about the minimum length, the spore wall is heavier or darker, and the shape more oblong-ellipsoid. The cystidia are very comparable in the two species. Small specimens that have become tawny in drying have a strong resemblance to specimens of *P. subsquarrosa* at New York from Bresadola, and microscopically the two are quite similar.

bbb. Pileus dry.

44. Pholiota squarrosa Fries, Syst. Myc. **1**: 243. 1821. Pl. 21.

Pileus 3–10 cm. broad, campanulate to convex or plane, yellowish or yellowish-brown, antimony-yellow to tawny in dried specimens, covered with rather large, recurved, tawny or yellowish scales, dry; flesh yellowish, taste mild; gills sinuate-adnate and often somewhat decurrent, medium-close, 3–6 mm. broad, pallid then ferruginous, in dried plants varying from honey-yellow to tawny-olive or tawny; veil forming a thick, persistent, floccose annulus often striate on the upper surface; stem central, equal, pallid, yellow or brown, with conspicuous recurved scales up to the annulus, solid, 5–12 cm. long, 5–12 mm. thick; spores oblong or ellipsoid, smooth, 6–8 × 3.5–4.5 μ; cystidia present, variable, of two general types: (a) hyaline, abundant, pointed at the apex, projecting, and (b) brown, blunt or truncate at the apex, mostly projecting, both types 25–35 × 7–14 μ.



Figs. 143–146. *P. squarrosa:* 143–145, sections of three gills from same plant showing various forms of cystidia (a), and spores (b), × 550; 146, spores, × 1200. All from Overholts Herb. No. 8058.

Habitat: on dead trunks or stumps of various trees, both deciduous and evergreen.

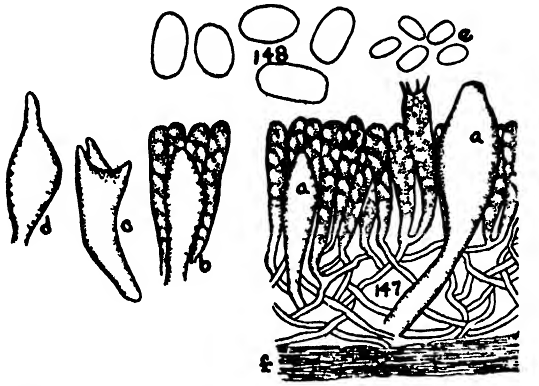
Distribution: specimens have been examined from Piscataquis Co., Me.; Stocktenridge, Mass.; Yama Farms and North Elba, N. Y.; Washington, D. C.; State College, Pa.; Jack Brook, Colo.; also reported from Michigan and Wisconsin by Harper.

Illustrations: Bernard, Champ. Roch. *pl. 19, f. 1;* Cooke, Ill. Brit. Fungi, *pl. 391 (367);* Hard, Mushrooms, *f. 217;* Hussey, Ill. Brit. Myc. **1**: *pl. 8;* Harper, Trans. Wis. Acad. Sci. **17**: *pl. 35;* Patouillard, Tab. Anal. Fung. *f. 340;* Peck, Rept. N. Y. State Mus. **55**: *pl. 79, f. 1–7.*

For detailed data as to the differences between *P. squarrosa* and *P. squarrosoides*, see the latter species.

45. Pholiota rigidipes Peck, Bul. N. Y. State Mus. 157: 31. 1912.

Pileus 4–8 cm. broad, broadly convex, sometimes slightly or broadly umbonate, pale yellow or buff, buff-yellow to ochraceous-buff or ochraceous-orange in dried plants, squamulose with scattered, appressed, slightly darker-colored, fibrillose scales that are more prominent in the center though never conspicuous and partially disappear in mature plants, dry; flesh white, tinged yellow next the gills, distinctly yellow in dried plants; taste mild; gills sinuate-adnate or adnate, medium-close, 3–7 mm. broad, cinnamon or ochraceous-tawny and retaining these colors in drying; veil forming a slight, often evanescent annulus; stem central, equal, pallid or yellowish and fibrillose-squamulose or becoming nearly glabrous below the annulus, white and pruinose at the top, stuffed or hollow, 5–9 cm. long, 4–6 mm. thick; spores oblong or oblong-ellipsoid, smooth, 6.5–8.5 × 3.5–4.5 μ; cystidia present, not always abundant, brown, some projecting, 25–40 × 6–8 μ.



Figs. 147–148. *P. rigidipes:* 147, section of hymenium showing cystidia (a) and spores (e), and central medulla (f), × 550; 148, spores, × 1200. All from type specimens.

Habitat: in woods, probably always on buried or exposed wood.

Distribution: specimens have been examined from Constableville and Utica, N. Y.; Forked River, N. J.; Creve Coeur Lake, Mo.

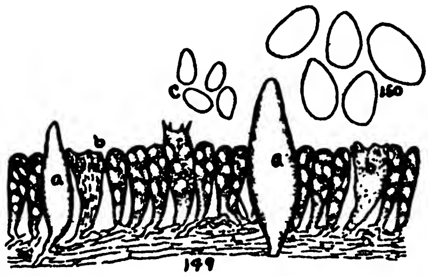
The species is well represented at Albany by the type collection which shows it to be a medium-sized plant with sparsely scaly pileus and fibrillose-scaly slender stem of the *P. adiposa* group. In spite of Peck's original note that it occurs on the ground among fallen leaves, I am of the opinion that it must have been attached to wood, perhaps buried wood. The aspect is much like that of

a *Flammula*. A second collection, perhaps referable here, is labeled *P. terrigena* and was collected by Atkinson, October, 1902. This collection has dirt attached to the basal part of the stem, but may have been also from buried wood. In both collections the flesh is distinctly yellow, close to lemon-yellow. The plant is not at all related to *P. angustipes*, as the scales are larger, more fibrillose, and scattered, and the colors are distinctly brighter.

46. **Pholiota Schraderi** (Peck) Overholts, N. Am. Fl. **10:** 271. 1924.

Stropharia Schraderi Peck, Bull. Torr. Bot. Club **32:** 80. 1905.

Pileus 5–8 cm. broad, convex to nearly plane, pallid when young, ochraceous-buff when mature, dry, fibrillose, squamulose, or rimose-squamulose on the disk; context white, with taste of radishes; lamellae adnate, close, thin, whitish then brown; annulus small, lacerate, white, sometimes evanescent; stem central, subequal, squamulose and concolorous with the pileus below, white and mealy above, solid, 2–4 cm. long, 8–12 mm. thick; spores ovoid, not apiculate, smooth, 6–8(–9) × 4–6 μ; cystidia rather abundant, hyaline, fusoid, projecting rather prominently; also irregular organs as though post-mature basidia imbedded in the hymenium.



Figs. 149–150. *P. Schraderi:* 149, section of hymenium showing cystidia (a–b), and spores (c), × 550; 150, spores, × 1200. All from type specimens.

Habitat: in sandy soil about stumps.

Distribution: known only from the type locality, Washington, D. C.

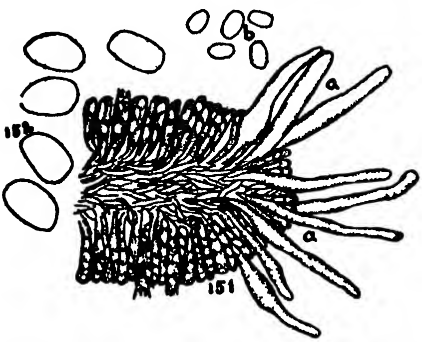
The plants are considerably like *P. fulvo-squamosa* but the stem is less prominently scaly, the spores are not at all apiculate, and cystidia are rather abundant and conspicuous. From *P. spectabilis* it differs in the smooth spores and the cystidia.

bb. Cystidia none.

aaa. Pileus 1–3 cm. in diameter (see also bbb, p. 162).

47. **Pholiota confragosa** Fries, Epicr. Syst. Myc. 169. 1836–38. Pl. 22, 23.

Pileus 1–2.5 cm. broad, convex to nearly plane, cinnamon-rufous when moist, tawny when dry, nearly uniform warm-buff or cinnamon-buff in dried plants, densely and finely floccose-squamulose or floccose-fibrillose under a lens, in age becoming somewhat denuded at times but never entirely so, hygrophanous, margin striate when moist; context fleshy-fragile, pallid, odor and taste not marked; gills adnate or slightly decurrent, sometimes white-crenulate on the edge, medium-close, 1–3 mm. broad, rufous to cinnamon-brown; veil forming a superior, membranous annulus, erect and sub-rigid for a time, finally more annulate and in rare cases all but disappearing; stem central, equal or enlarged just at base, concolorous with the pileus or paler, markedly fibrillose below the annulus and sometimes white-tomentose or strigose at the base, floccose and sometimes striate above, 2–5 cm. long, 1.5–5 mm. thick; spores ellipsoid or broadly ellipsoid, smooth, not truncate, dilutely colored under the microscope, 6–8 × 4–5 μ; cystidia none except for radiating tufts on the edge of the gill.



Figs. 151–152. *P. confragosa:* 151, section of edge of a gill showing the clavate or lance-shaped sterile cells (a), and spores (b), × 550; 152, spores, × 1200. All from Overholts Herb. No. 8061.

Habitat: rotten mossy trunks of deciduous trees.

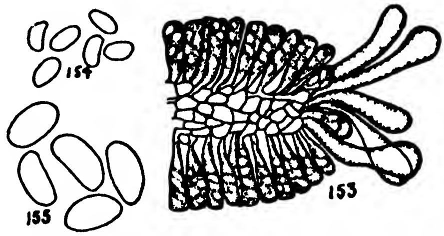
Distribution: specimens have been examined from Sebec Lake, Me.; Mt. Mansfield, Vt.; Stockbridge, Mass.; Lake Placid, Adirondack Mts., and Fourth Lake (Herkimer Co.), N. Y.; also reported from Michigan by both Harper and Kauffman.

Illustrations: Fries, Ic. Hym. *pl. 105, f. 2;* Harper, Trans. Wis. Acad. Sci. **17:** *pl. 41, f. D, E.*

When once learned this species is among the easiest to recognize by the peculiar constant color, especially of dried plants, and the matted fibers on the pileus, resembling as seen under a lens, the pileus fibers in *P. caperata* or *P. comosa* as seen without a lens.

48. **Pholiota erinaceella** Peck, Rept. N. Y. State Mus. **30:** 70. 1878.

Pileus 0.5–2.5 cm. broad, hemispheric then convex or nearly plane, tawny-brown, not changing color in drying, dry, densely covered with minute, erect, pyramidal, spine-like, or granular, tawny scales; gills adnexed or adnate, medium-close or subdistant when young, 1–2 mm. broad, pallid then cinnamon-brown; veil forming a slight, superior, floccose, evanescent annulus; stem central, equal, tawny, with numerous floccose scales or granules below the annulus, smooth above, stuffed or hollow, 1.5–2.5 cm. long, 1–1.5 mm. thick; spores ellipsoid or naviculoid, smooth, very dilute brown under the microscope, 6–8 × 4–5 μ; cystidia none on the sides of the gills, protruding abundantly from the edge of the gills.



Figs. 153–155. *P. erinaceella:* 153, section of edge of gills showing clavate sterile cells, × 550; 154, spores, × 550; 155, spores, × 1200. All from Overholts Herb. No. 3751.

Habitat: on dead wood of deciduous trees.

Distribution: specimens have been examined from Lake Pleasant and Boreas, N. Y.; St. Louis, Mo.; also reported by Harper from Michigan.

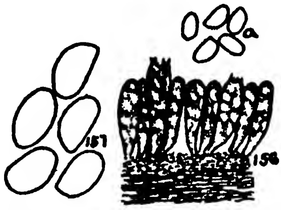
Illustrations: Harper, Trans. Wis. Acad. Sci. **17:** *pl. 51.*

The species is well marked by the small stature, the covering of spine-like scales on both pileus and stem, and the tufts of cystidia on the edges of the gills. *Agaricus (Pholiota) detersibilis* Peck is a synonym.

49. **Pholiota muricata** Fries, Syst. Myc. **1:** 244. 1821. Pl. 14.

Pileus 1–3 cm. broad, convex to plane, obtuse or often slightly umbilicate-depressed, golden-brown or tawny-yellowish when fresh, brown or cinnamon-brown in dried plants, covered by a dense cuticle of short tawny fibrils or fibrillose-tufted scales, or granulose-squarrose at the center, dry; flesh thin, yellowish, taste none, odor mild; gills sinuate-adnate, often nearly free in age, medium-close or slightly distant, light yellow then cinnamon-brown or rusty-brown, the edge white-crenate, 3–4 mm. broad;

veil forming an indistinct superior evanescent annulus; stem central, equal, yellowish but with few, rusty-brown, fibrillose, sub-erect scales or becoming nearly glabrous, stuffed then hollow, 3–7 cm. long, 2–5 mm. thick, sometimes with a bright yellow mycelium at the base; spores ellipsoid, smooth, 6–8 × 3.5–4 μ; cystidia none.



Figs. 156–157. *P. muricata:* 156, section of hymenium showing spores (a), × 550; 157, spores, × 1200. All from specimen at New York from Michigan.

Habitat: on rotting logs of deciduous trees.

Distribution: specimens have been examined from Ann Arbor, Michigan; also reported from Illinois by Harper.

Illustrations: Harper, Trans. Wis. Acad. Sci. **17:** *pl. 52, 53.*

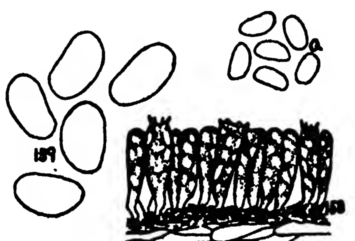
The species as here understood is based on plants collected by Kauffman in Michigan. There is a resemblance to *P. curvipes* but the colors are not so bright and the gills in particular are not bright ochraceous-orange as in that species. The scales on the pileus are also different. *P. erinaceella* may not be distinct but is a smaller plant, with more spine-like scales and more brown in color.

bbb. Pileus 2.5–7 cm. broad.

50. Pholiota lucifera (Lasch) Fries, Epicr. Syst. Myc. 167. 1836–38.

Agaricus luciferus Lasch, Linnaea **3:** 408. 1828.

Pileus 2–5 cm. broad, convex or plane, uniformly yellow, ochraceous-buff or ochraceous-orange in dried plants or the center more tawny, viscid, decorated with small yellowish or tawny squamules; flesh yellow; gills adnate, close, 2–4 mm. broad, yellow then bright rusty-brown, white-crenulate on the edge when young; veil forming a superior evanescent annulus; stem central, equal or slightly thickened at the base, solid, yel-



Figs. 158–159. *P. lucifera:* 158, section of hymenium with spores (a), × 550; 159, spores, × 1200. All from specimens at New York from Bresadola.

lowish above, brownish below, peronate-fibrillose, 2–5 cm. long, 3–8 mm. thick; spores oblong-ellipsoid or bean-shaped, smooth, 7–9 × 4–5 μ; cystidia none.

Habitat: on dead trunks and limbs.

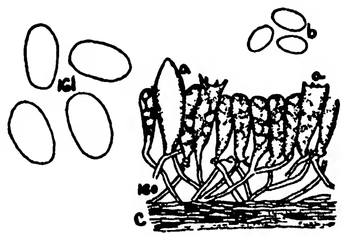
Distribution: reported by Kauffman from Michigan.

Illustrations: Bresadola, Fung. Trid. **1:** *pl. 85;* Ricken, Blätterp. *pl. 54, f. 1.*

European authors agree in describing the plant as with a peronate stem, i.e., with a distinct sheath that is at first continuous as the veil over the pileus. Bresadola represents it as somewhat glutinous or at least forming glutinous scales. In this character it seems to be different from *P. limonella.* I have seen no American specimens of this plant.

51. **Pholiota limonella** Peck, Rept. N. Y. State Mus. **31:** 33. 1879.

Pileus 2.5–5 cm. broad, convex or nearly plane, sometimes umbonate, lemon-yellow when fresh, retaining the color in the dried plants or becoming slightly tawny, with scattered, reflexed or suberect, fibrillose, reddish or tawny scales, viscid; flesh thin, yellow; gills sinuate-adnate or slightly adnexed, close, 2–4 mm. broad, whitish, becoming ferruginous, honey-yellow or cinnamon-buff in dried plants; veil forming a floccose, evanescent, yellow annulus; stem central, equal, yellowish, with scattered recurved yellow scales, smooth above the annulus, solid, 3–7 cm. long, 3–5 mm. thick; spores ellipsoid or ovoid, smooth, deep brown, 6.5–7.5 × 4.5–5 μ; cystidia none; trama with a distinct central medulla.



Figs. 160–161. *P. limonella:* 160, section of hymenium showing cystidia (a), spores (b), and central medulla (c), × 550; 161, spores, × 1200. All from type specimens.

Habitat: prostrate trunks of beech and birch.

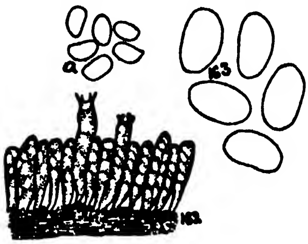
Distribution: specimens have been examined only from Griffins, N. Y.

Although this species might be compared to *P. flammans* yet the colors are different, the spores are larger, sterile organs are absent from the hymenium, and the plant lacks the yellow pulverulent

appearance of dried plants of that species. It may not be distinct from *P. lucifera.*

52. Pholiota tuberculosa Fries, Syst. Myc. **1**: 244. 1821.
Pl. 14.

Pileus 2–6 cm. broad, convex to plane, rarely depressed, obtuse, more or less ochraceous-orange, ochraceous-tawny in herbarium specimens, dry, glabrous when young, soon breaking up into appressed or erect innate squamules; flesh yellow, thin, taste mild, odor none; gills emarginate or becoming free, broad, yellow then tawny, the edge serrate; veil forming a superior, often evanescent annulus; stem central, with a prominent bulb just at base and rooting below, fibrillose or slightly scaly, incurved, hollow, yellowish, 1.5–3 cm. long, 1–5 mm. thick; spores ellipsoid or oblong-ellipsoid, smooth, 6–8.5 × 4–5 μ; cystidia none.



Figs. 162–163. *P. tuberculosa:* 162, section of hymenium with spores (a), × 550; 163, spores, × 1200. All from specimens at New York from Europe by Bresadola.

Habitat: on dead wood of deciduous trees.

Distribution: reported by Harper from Michigan.

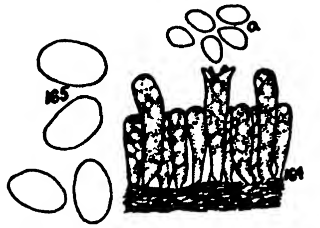
Illustrations: Cooke, Ill. Brit. Fung. *pl. 398a* (*370*); Fries, Ic. Hym. *pl. 104, f. 2;* Harper, Trans. Wis. Acad. Sci. **17**: *pl. 41, A, B.*

I have seen no plants referable to this species. Harper's specimens seem to meet the requirements, although the spore measurements (3 × 5–6 μ) are somewhat smaller than I find in European plants.

53. Pholiota curvipes Fr. Epicr. Syst. Myc. 168. 1836–38.

Pileus 2–5 cm. broad, convex to plane, ochraceous-orange, more tawny in age and in herbarium specimens, at first innately floccose or densely silky-floccose, in age breaking up into small fibrillose scales, even, dry; margin even, sometimes appendiculate from the veil; flesh yellow, thin, taste mild, odor none; gills adnate, medium-close to slightly distant, bright ochraceous-orange when mature and in dried specimens, the edge white or

yellow, conspicuously floccose-crenate, 3–6 mm. broad; veil forming a superior, soon evanescent, radiate-floccose annulus, or annulus none; stem central, equal or tapering upward, ochraceous-orange or ochraceous-tawny, clear yellow at apex, decidedly floccose-fibrillose, hollow, 2–5 cm. long, 2–5 mm. thick; spores ellipsoid or oblong-ellipsoid, smooth, 7–8.5 × 4–5 μ; cystidia none.



Figs. 164–165. *P. curvipes:* 164, section of hymenium with spores (a), × 550; 165, spores, × 1200. All from specimen at New York from Sebec Lake, Maine.

Habitat: on dead wood of deciduous trees.

Distribution: specimens have been examined from Sebec Lake, Me.; Osceola, N. Y.; and Creve Coeur, Mo.; also reported from Ann Arbor, Mich., by Kauffman.

Illustrations: Fries, Ic. Hym. *pl. 104, f. 3;* Cooke, Ill. Brit. Fungi, *pl. 398* (*370*) *b.*

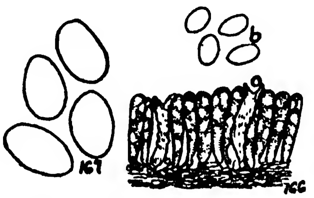
Among the similar-appearing species in the genus *Flammula* and the related species in *Pholiota* it is extremely difficult to set up specific limitations that will hold. Kauffman seems certainly to have had my plant, although descriptions are hardly adequate for the determination of species in this group. In the several hundred collections of *Pholiota* at the New York Botanical Garden I found but one that I think is undoubtedly this species as illustrated by Fries. Burt has made two collections in Missouri that agree in all respects with my conception of this species. The cap is nearly uniformly ochraceous-orange, the gills of about the same color near the margin of the pileus, but darker and more sordid toward the stem, and the stem is practically concolorous *throughout* with the pileus. In the dried plant the scales on the pileus are appressed and very slightly darker than the cuticle. Another collection agreeing even more closely with Fries' illustration is in the herbarium at Albany and a portion in the writer's herbarium. It was collected in New York by Peck. While the colors here would indicate a relationship with *P. limonella,* yet the stem there is distinctly clothed with recurved floccose scales and the gills are more sinuate or even adnexed as they are also in *P. flammans,* which species differs further in having much smaller spores. The

affinities of the species appear to me to be more with these enumerated than with *P. muricata* and *P. erinaceella*. *P. lucifera* seems to differ in having a lemon-yellow viscid pileus and a scaly stem. It is reported on the wood of coniferous trees.

Without seeing the plants described and figured under this name by Harper I cannot admit their identity. The scales and the gills are both described as tawny while in my plants they are much brighter in color.

54. Pholiota angustipes Peck, Rept. N. Y. State Mus. **30:** 40. 1878. Pl. 23.

Plants cespitose, 2.5–7 cm. broad, hemispheric becoming convex or nearly plane, brown or grayish-brown, becoming ochraceous-brown or subalutaceous, drying between avellaneous and cinnamon-buff or somewhat ochraceous-tawny, slightly viscid when moist, squamulose with minute, dot-like appressed scales; context fleshy, thin, yellowish or whitish, taste unpleasant; gills sinuate-adnate to adnate or slightly decurrent, medium-close, 3–6 mm. broad, whitish or creamy-yellow, becoming tawny-brown, but cinnamon-buff or cinnamon in dried plants; veil forming a slight, usually evanescent annulus; stem central, equal or tapering downward, whitish to avellaneous, slightly squamose or fibrillose, stuffed or hollow, 3–7.5 cm. long, 4–12 mm. thick; spores ellipsoid, smooth, dilute-brown under the microscope, 6–8 × 3–5 μ; cystidia none or scarcely noteworthy as small collapsed basidium-like bodies, brown in color, and occurring with the basidia.



Figs. 166–167. *P. angustipes:* 166, section of hymenium with the inconspicuous sterile cells (a), and spores (b), × 550; 167, spores, × 1200. All from type specimens.

Habitat: in pastures or open woods, commonly near or around old stumps.

Distribution: specimens have been examined from Schenevus, Staten Island, and Menands, N. Y.; West Elkton, Ohio; also reported by Harper from Madison, Wis.

Illustration: Harper, Trans. Wis. Acad. Sci. **17:** *pl. 34.*

The species is a well-marked one in the pallid to brown color-

ation and the minute scales that thickly cover the pileus and to the unaided eye give the appearance of small dots. Yet in one ample collection from Ohio some specimens are decidedly squamulose, while other younger ones are entirely glabrous. This same collection has a reddish hue to the center of the pileus that is not mentioned in the notes on the fresh specimens. The sterile organs in the hymenium are quite inconspicuous but show up much more strongly when the sections are cleared in glycerine. No distinct annulus is formed and the species may fit better in *Flammula* than in *Pholiota*. Harper's photograph is excellent, showing extremely well the dot-like scales on the pileus.

ccc. Pileus 6–15 cm. in diameter.

55. **Pholiota fulvo-squamosa** Peck, Bul. Torr. Bot. Club **30:** 95. 1903. Pl. 13.

Pileus fleshy, 6–12 cm. broad, rather thin, convex becoming nearly plane, dry, covered with a tawny fibrous cuticle of brownish fibrillose scales, the lighter-colored flesh showing up when the fibers separate into scales, sometimes concentrically cracked about the disk; flesh white, becoming brownish where cut, with taste and odor of radishes; gills rather narrow, close, adnate or joined to a slight collar around the stem, whitish becoming pinkish-cinnamon then dark cinnamon with a white-crenulate edge; annulus ample, membranous, persistent, scaly below, the upper surface striate; stem central, equal, stuffed or hollow, covered below the ring with numerous, erect, subfloccose, tawny scales, slightly floccose above the annulus, 5–8 cm. long, 8–10 mm. thick; spores elliptic or ellipsoid, rather strongly apiculate at the base, dark ferruginous-brown, smooth, 6–8 × 3.5–4.5 μ; cystidia none or not noteworthy.

Figs. 168–169. *P. fulvo-squamosa:* 168, section of hymenium with spores (a), × 550; 169, spores, × 1200. All from Overholts Herb. No. 934.

Habitat: about the bases of trees or attached to buried wood.

Distribution: Michigan.

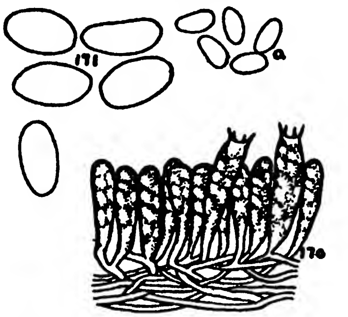
Illustration: Harper, Trans. Wis. Acad. Sci. **17:** *pl. 60.*

I have seen no specimens of this plant other than the type at

Albany. At first glance the dried plant looks much like an *Agaricus*, similar to *A. subrufescens*. The gills are quite narrow as in *P. duroides*. The spores are quite dark and very similar to those of *Agaricus* but no *Agaricus* has so pronounced a scaliness on the stem. Harper notes the absence of the radish odor and the color change of the flesh and gives excellent figures of the plant.

56. Pholiota destruens Brond. Plant Crypt. de l'Agen, *pl. 6*. 1828–30.

Pileus 6–15 cm. broad when mature, heavy-fleshy, convex to expanded, sometimes umbonate, pallid or more often cervine or wood-brown, the cuticle sometimes weathering off to a white color, subviscid, with scattered, large, white, floccose patches or squamules that are rather adnate and sometimes imbricate and may disappear, or with soft white scales; margin frequently rivulose and with white fibrils or fibrillose scales; flesh white, thick, odor not marked, taste mild or saponaceous; gills adnate to sinuate, close or crowded, at first white, finally deep cinnamon, 4–14 mm. broad; veil white, soon breaking, forming an evanescent, white, floccose-tomentose annulus; stem central or excentric, equal or enlarged downward, white floccose-tomentose above the annulus, with a few large white squamules or indistinctly and broadly peronate from the veil fibers, white to wood-brown, 5–15 cm. long, 1–6 cm. thick, solid; spores ovoid or ellipsoid, smooth, 7.5–9.5 × 4–6 μ; cystidia none.



Figs. 170–171. *P. destruens*: 170, section of hymenium with spores (a), × 550; 171, spores, × 1200. All from specimens at New York from Kansas by Bartholomew.

Habitat: on stumps and trunks of *Populus* and other deciduous trees.

Distribution: specimens have been examined from Charlotte, Pittsford, Knowersville, and Utica, N. Y.; Oxford, Ohio; River Forest, Ill.; Indianapolis, Ind.; St. Louis, Mo.; Kansas; Denver and Boulder, Colo.; Priest River, Idaho; Sequim, Wash.; also reported by Harper from Frankfort, Mich. (as *P. heteroclita* and *P. comosa*).

Illustrations: Bresadola, Fung. Trid. *pl. 84;* Hard, Mushrooms, *f. 214;* Harper, Trans. Wis. Acad. Sci. 17: *pl. 45–47;* Kalchbrenner, Ic. Hym. Hung. *pl. 13, f. 1* (as *P. comosa*).

Bresadola considers *P. comosa* and *P. heteroclita* as synonyms of this species, and he has been followed in this country by Kauffman. Harper, on the other hand, describes and illustrates *P. comosa* from Michigan and Illinois as covered with small white innate fibrils that become separated into small appressed scales, while his *P. heteroclita* seems to compare better with the plants I have referred to *P. destruens*. At best these plants are all very closely related and specific limitations are largely a matter of individual opinion.

Notes on a collection made near St. Louis by Glatfelter describe the taste as sweet at first, becoming bitter.

Supplementary Key to the Species

1. Spores rough at maturity (either distinctly so under the high power of the microscope or requiring the use of the oil-immersion lens) 2
   Spores smooth at all stages 9
2. Wood-inhabiting;[1] fresh plants bright-colored, i.e., some shade of yellow, green, or red; gills frequently bright-colored; not viscid; spores 6–10 μ long; cystidia not noteworthy 3
   Wood-inhabiting;[1] gills not bright-colored but cinnamon; spores mostly 6–10 μ long; cystidia present though not always abundant, flask-shaped with a projecting neck 6
   Ground-inhabiting, in woods; spores variable, but in all species except one more than 10 μ long 7
   Among *Polytrichum* moss on the ground; very small plants, less than 1 cm. broad; stem 1–2 mm. thick .... *P. minima*
3. Pileus with distinct shades of green or ashy-green when young or on being handled; flesh green-tinged; gills bright-colored (yellow to ochraceous-orange) and remaining so in dried plants; pileus scaly with fibrillose scales .... *P. aeruginosa*
   Plants not *entirely* as above 4
4. Pileus 2–5 cm. broad, typically pinkish-red in color, squamulose with innate scales (i.e., not formed by the separating of a fibrillose cuticle on the pileus); flesh usually pale lavender; gills bright-colored in dried plants .... *P. luteofolia*
   Plants not entirely as above 5
5. Pileus 4–15 cm. broad at maturity, dry, glabrous or fibrillose, or if somewhat squamulose then the scales definitely formed by the separation of a fibrillose cuticle; taste bitter or amygdaline .... *P. spectabilis*

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[1] Plants found growing in clusters from a common point, apparently on the ground, are likely to be attached to buried wood, but this point should be carefully investigated when making the collection.

Pileus hygrophanous, glabrous, otherwise as in *P. spectabilis*....... *P. cerasina*

6. Plants hygrophanous (never viscid), watery-brown and striatulate on the margin when moist, ochraceous on drying, cinnamon to tawny in herbarium specimens, not at all scaly; gills simple; annulus soon evanescent or leaving only a band on the stem........................ *P. marginata*

Plants as above except pileus viscid, annulus sometimes persistent, and dried plants cinnamon-buff to cinnamon....................... *P. discolor*

Plants as in *P. marginata* except annulus membranous, persistent, conspicuous... *P. unicolor*

Plants as in *P. marginata* except gills distinctly forking............. *P. furcata*

7. Spores broadly-ovoid to subglobose, 7–9 × 5–6 μ, distinctly verrucose; pileus entirely covered with matted floccose fibrils, or these collected into squamules at the center of the pileus; plants with somewhat the aspect of *Cortinarius*................................ *P. trachyspora*

Spores ellipsoid or elliptic, more than 12 μ long, distinctly verrucose.........8

8. Plants slimy-viscid, glabrous; gills not conspicuously banded with alternating light and dark transverse bands; plants western.... *P. Mcmurphyi*

Pileus scarcely moist or sub-viscid, young plants with a coating of hoary fibrils; gills conspicuously banded with transverse light and dark bands, particularly in dried plants; plants eastern................... *P. caperata*

9. Plants growing on the ground[1] and with *either* pileus or stem *or both* scaly....10

Plants growing on the ground[1] or among moss and with *neither* pileus nor stem scaly, or at most only floccose or scurfy.........................17

Plants growing on wood[1] and with *either* pileus or stem *or both* scaly or with floccose patches...35

Plants growing on wood[1] and with neither pileus nor stem scaly............52

10. Stem scaly...13

Stem not scaly or at most only strongly floccose or scurfy................11

11. Spores constantly 6 μ or less long; annulus membranous, disappearing .... *P. duroides*

A considerable number of spores in each mount measuring as much as 8 or 9 μ long; annulus a persistent cottony roll on the stem...............12

Spores 9–12 μ long; annulus membranous, disappearing............. *P. aurea*

12. Pileus brown, ochraceous-brown, or ochraceous-tawny, minutely scaly all over; annulus slight, evanescent........................ *P. angustipes*

Pileus ochraceous to pallid, minutely scaly only at the center; annulus a persistent cottony roll on the stem .... *P. Johnsoniana*

13. Sterile organs of conspicuous form or color entirely lacking from the hymenium; pileus and stem covered with a fibrillose cuticle that soon separates into soft silky scales on both pileus and stem.................14

Sterile organs present in the hymenium, sometimes projecting but sometimes with the aspect of over-mature basidia, and brown in color and not projecting; plants not otherwise as above..........................15

14. Spores 6–8 μ long, rather strongly apiculate................ *P. fulvo-squamosa*

Spores 8–9 μ long, not apiculate............................. *P. terrigena*

[1] Plants found growing in clusters from a common point, apparently on the ground, are likely to be attached to buried wood, but this point should be carefully investigated.

15. Scales of the pileus scattered, appressed, sometimes all but disappearing, rather large; cystidia as brown sterile organs, some imbedded but many projecting, of definite form; pileus yellow or buff.............. *P. rigidipes*
Scales of the pileus numerous, small, and appearing as black dots to the unaided eye, or medium-sized and more conspicuous; cystidia not as above...16
Scales of the pileus none; cystidia abundant, projecting, flask-shaped. *P. subnigra*
16. Cystidia occasional, not of definite form but mostly as inconspicuous brown organs comparable to post-mature basidia, but usually not projecting; pileus pale brown or pinkish-cinnamon, 3–7 cm. broad.. *P. angustipes*
Cystidia abundant, projecting, sharp-pointed, many hyaline or with rounded brownish globules inside; plants dark brown, 1–3 cm. broad .... *P. terrestris*
Cystidia rather numerous, projecting, fusoid, hyaline; plants 5–8 cm. or more broad when mature, ochraceous-buff................... *P. Schraderi*
17. Spores ovoid or narrow-ovoid with a truncate apex and base more or less obtuse or rounded though sometimes apiculate........................18
Spores variously shaped, not truncate at the apex but sometimes apiculate at the base...27
18. Spores narrow-ovoid, 4–5 μ broad, or else annulus median, conspicuous, striate on the upper side; cystidia none; slender plants not more than 4 cm. broad...19
Plants not entirely as above..23
19. Plants growing in wet places among *Sphagnum* moss.......... *P. mycenoides*
Plants not as above..20
20. Plants watery-brown, ochraceous in herbarium specimens; stem 2–10 cm. long..21
Plants yellowish-red or dark ferruginous and retaining these colors in herbarium specimens; stem 1–2.5 cm. long...................... *P. rugosa*
21. Spores 6.5–9 μ long....................................... *P. blattaria*
Spores 9–10.5 μ long...22
22. Stem 2 mm. or more thick; medium-slender plants more than 1 cm. broad .... *P. togularis*
Stem about 1 mm. thick; very slender plants less than 1 cm. broad.... *P. filaris*
23. Plants growing on the ground in cultivated fields or grassy places, or in open grassy woods, or among straw or other waste vegetable matter carried into the woods..24
Plants growing on the ground in dense woods, or growing on wood..........26
24. Spores 10–14 μ long; cystidia scarcely projecting, the apex broadly rounded; pileus white, soon areolate............................. *P. vermiflua*
Plants not entirely as above; spores 8–10.5 μ long; cystidia flask-shaped and projecting conspicuously if present.................................25
25. Spores 4–6 μ broad; pileus white or tinged with yellow or tan; gills narrow or medium-broad... *P. praecox*
Spores 6–7 μ broad; pileus ochraceous-yellow; gills very broad.... *P. temnophylla*
26. Plants growing on wood or on rich humus; pileus rugose at times. *P. Acericola*
Plants growing on the ground; pileus never rugose................ *P. Howeana*
27. Spores up to 9 μ long..28
Spores more than 9 μ long..33

28. Plants growing among *Polytrichum* moss, small, less than 1 cm. broad; spores finely verrucose under the oil-immersion lens............. *P. minima*
Plants not entirely as above..29
29. Plants small or medium-sized, less than 4 cm. broad; cystidia none or not noteworthy..30
Plants larger; cystidia various, sometimes absent........................31
30. Annulus median, long-persistent, striate on the upper surface.... *P. blattaria*
Annulus superior, evanescent................................. *P. anomala*
31. Plants western; pileus slimy-viscid; stem conspicuously white-tomentose just below the annulus..................................... *P. albivelata*
Plants eastern; pileus dry; stem not white-tomentose.....................32
32. All spores 6 μ or less long; cystidia rather abundant but not conspicuous, mostly with a mucronate tip; annulus membranous, disappearing. *P. duroides*
Some spores in every mount as much as 8 or 9 μ long, mostly 5–9 μ; cystidia quite rare and scarcely noteworthy, or abundant and conspicuous; annulus a cottony roll on the stem........................ *P. Johnsoniana*
33. Plants small, less than 2 cm. broad............................ *P. subnigra*
Plants larger, 2–10 cm. broad......................................34
34. Plants 2–5 cm. broad; gills adnate or slightly decurrent; stem fibrillose below the annulus... *P. erebia*
Plants as above, but stem concentrically white-zoned from the veil. *P. platyphylla*
Plants 4–10 cm. broad; gills distinctly decurrent................ *P. ombrophila*
Plants 10–15 cm. broad; gills 7–20 mm. broad, rounded behind......... *P. aurea*
35. Spores 9 μ or less long, or if somewhat longer, then pileus glabrous..........36
Spores 9–11 μ long, oblong-ellipsoid; brown sterile organs present in the hymenium; plants western; pileus scaly.................. *P. aurivelloides*
Spores 11–14 μ long, broadly-elliptic or fusoid-elliptic; brown sterile organs absent from the hymenium; plants eastern; pileus scaly. *P. albocrenulata*
36. Stem only scaly and spores with a truncate apex; small plants up to 3 cm. broad; no sterile organs in the hymenium................. *P. mutabilis*
Plants not entirely as above..37
37. Spores 3–6 μ long..38
Spores 6 μ and more long...39
38. Pileus pallid to cinnamon when fresh, viscid, densely scaly with erect or sub-erect, pointed, concolorous scales; stem with concolorous scales .... *P. squarrosoides*
Pileus lemon-yellow to tawny or fiery-yellow when fresh, dry, with fibrillose, superficial, sulphur-yellow scales; the stem with yellow floccose scales or scarcely more than yellow flocci................... *P. flammans*
39. Plants pallid to brown, grayish-brown, or ochraceous-brown; pileus squamulose, with abundant minute dot-like appressed scales, never areolate, 3–7 cm. broad; stem only slightly, if at all, scaly; no conspicuous projecting sterile organs[1] in the hymenium; spores 6–8 μ long. .... *P. angustipes*
Plants ochraceous-buff to ochraceous-tawny; pileus glabrous; gills somewhat distant, strongly interveined; stem 8–20 mm. thick, with small subfloccose evanescent scales; spores 7.5–9.5 μ long.......... *P. oregonense*

[1] But there are usually present more inconspicuous bodies, not projecting, and with the appearance of old basidia, irregular in shape. These are apt to show up particularly well in permanent sections in glycerine.

Plants not *entirely* as in either of the above 40

40. Hymenium with numerous sterile brown organs, imbedded or projecting; all species bright-colored, yellow, reddish, or tawny, and with both pileus and stem scaly, and pileus more than 5 cm. broad 41

Hymenium with distinct projecting hyaline fusoid cystidia; pileus appressed-squamose and often areolate; stem squamulose .... *P. Schraderi*

Hymenium without sterile brown organs or cystidia except perhaps on the edges of the gills; other characters variable 44

41. Pileus with large appressed spot-like scales; stem increasingly scaly downward .... *P. aurivella*

Plants not entirely as above 42

42. Pileus viscid .... *P. adiposa*

Pileus dry 43

43. Pileus with appressed scales; stem only inconspicuously scaly, 4–6 mm. thick .... *P. rigidipes*

Pileus with recurved scales; stem conspicuously scaly with recurved scales and 5–12 mm. thick .... *P. squarrosa*

44. Large species, 6–15 cm. broad, white to pallid or wood-brown, with large white floccose spots or patches on the pileus; spores 7.5–9.5 μ long.. *P. destruens*

Large species 6–12 cm. broad, with fibrillose scales; plants growing at the base of trees or attached to buried wood; spores 6–8 μ long, strongly apiculate .... *P. fulvo-squamosa*

Plants not entirely as above 45

45. Both pileus and stem scaly 46

Pileus only scaly 49

46. Pileus deep rich brown or golden brown to tawny 47

Pileus brighter-colored, lemon-yellow to ochraceous-orange 48

47. Both pileus and stem densely covered with a sheath of small erect, conical, superficial scales .... *P. erinaceella*

Pileus covered with a dense coating of soft fibrillose scales that are erect, if at all, only in the center of the pileus; stem sparingly scaly or only fibrillose, not sheathed .... *P. muricata*

48. Stem with a distinct bulb just at base; not sheathed but scaly... *P. tuberculosa*

Stem not with a bulb at the base, but sheathed and scaly .... *P. lucifera*

Stem not with a bulb at the base; not sheathed but scaly .... *P. limonella*

49. Pileus 1–2.5 cm. broad, hygrophanous; gills cinnamon; annulus distinct, persistent, membranous .... *P. confragosa*

Pileus 2–10 cm. broad; gills bright ochraceous-orange; annulus fibrous-lacerate and evanescent 50

50. Pileus viscid .... *P. lucifera*

Pileus dry 51

51. Pileus soon areolate and often with greenish tints; edge of gills concolorous .... *P. aeruginosa*

Pileus not areolate, never greenish; edge of gills conspicuously white-crenate .... *P. curvipes*

52. Pileus floccose or silky-floccose, 2–5 cm. broad; gills, pileus, and stem bright ochraceous-orange .... *P. curvipes*

Plants not entirely as above 53

53. Plants uniformly less than 4 cm. broad 54

Plants at maturity more than 4 cm. broad 56

54. Spores with a truncate apex, 6–8 μ long; cystidia none; veil evanescent .... *P. marginella*

Spores not truncate, 7.5–9.5 μ long; flask-shaped cystidia present and projecting, though not abundant 55

55. Pileus viscid; annulus subpersistent .... *P. discolor*

Pileus dry; annulus at first funnel-shaped, persistent and conspicuous .... *P. unicolor*

Pileus dry; annulus usually persistent but not funnel-shaped.... *P. marginata*

56. Pileus ochraceous to tan; annulus long-persistent, membranous............ 57

Pileus bright-colored, ochraceous-buff to tawny; annulus soon evanescent; gills rather distant and the gill cavities strongly veined........ *P. oregonense*

57. Cystidia rather abundant, flask-shaped, strongly projecting; pileus often rugose; on rotten wood or on humus........................ *P. Acericola*

Cystidia present and rather abundant but projecting only slightly and more fusoid than flask-shaped; on recently felled logs or from wounds of living trees... *P. Aegerita*

Synonyms and Doubtful and Excluded Species

Pholiota aggericola Peck is *P. erebia* of this paper. See p. 119.

Pholiota appendiculata Peck, Bul. N. Y. State Mus. 94: 33. 1905. = *P. ornella* Peck, which is referable to *Flammula polychroa* Berk.

Pholiota autumnalis Peck is *P. marginata* (Batsch) Fries. See p. 134.

Pholiota dactyliota (Berk. & Mont.) Sacc. Syll. Fung. 5: 750. 1887 (*Agaricus dactyliotus* Berk. & Mont.; Mont. Syll. Crypt. 115. 1856). Described from plants collected in Ohio by Sullivant, and said to be similar to *P. squarrosa*.

Pholiota comosa Fries is here regarded as a form of *P. destruens* Brand. See p. 169.

Pholiota detersibilis Peck is *P. erinaceella* Peck. See p. 161.

Pholiota dura (Bolt.) Quel. Champ. Jura Vosg. 91. 1872 (*Agaricus durus* Bolt. Hist. Fung. *pl. 67, f. 1.* 1788). A species reported in every list of fleshy fungi issued in America. All collections examined belong as well under *P. vermiflua* Peck which will probably be found to be a synonym of *P. dura*. Europeans are far from an agreement as to the limits of the species and Peck's name can be used for the present. See p. 105.

Pholiota heteroclita Fries is here regarded as not distinct from *P. destruens* Fries. See p. 169.

Pholiota hormophora (Mont.) Sacc. Syll. Fung. 5: 754. 1887

(*Agaricus hormophorus* Mont. Syll. Crypt. 116. 1856). Collected by Sullivant in Ohio and described by Montagne. Said to resemble *P. tuberculosa* Fries and is described as having a bulbous enlargement at the base of the stipe.

Pholiota indecens Peck is *P. ombrophila* Fries. See p. 121.

Pholiota lutea Peck is here treated as a form of *P. spectabilis* Fries. See p. 145.

Pholiota luxurians (Fries) Gill. Champ. Fr. 439. 1876. Reported by Harper from the Great Lakes region. The specimen seems to be related to *P. aeruginosa* Peck.

Pholiota mollicula Banning in Peck, Rept. N. Y. State Mus. **44**: 182 (70). 1891. Originally described from Maryland, growing on the roots of trees.

Pholiota ornella Peck, Bul. N. Y. State Mus. 122: 151. 1908 (*Agaricus ornellus* Peck, Rept. N. Y. State Mus. **34**: 42. 1883). Not distinct from *Flammula polychroa* Berk.

Pholiota radicosa (Bull.) Quel. Champ. Jura Vosg. 92. 1872 (*Agaricus radicosus* Bul. Herb. Fr. *pl. 160.* 1783). Reported from the Pacific coast by Harkness and Moore but I have seen no specimens of this highly characteristic species.

Pholiota sabulosa Peck, Bul. Torr. Bot. Club **23**: 414. 1896. Described as growing in sandy soil in Alabama. The spores are rough-walled, 8.5–9.5 × 5–6 μ. Flask-shaped cystidia project from between the basidia. Both of these characters ally the plant to the *P. marginata* complex in which there is already an overabundance of described species. Specimens in the Underwood Herbarium at New York show the plant to have been growing from humus-charged earth, and it is probably to be regarded as a form of *P. marginata* or *P. discolor*.

Pholiota speciosa Clements, Bot. Surv. Neb. **2**: 41. 1893. The description is inadequate for the recognition of the species. If the spore measurements (5 × 4.5 μ) are correctly recorded it would fall in the neighborhood of *P. duroides*, with which it seems to have other characters in common.

Pholiota sphaleromorpha (Bull.) Quel. Champ. Jura Vosg. 91. 1872 (*Agaricus sphaleromorphus* Bull. Herb. Fr. *pl. 540.* 1791). Harper is of the opinion that *P. Howeana* Peck is referable to this species. At all events it is very similar and there are now too

many species described with the peculiar truncate spores, the prominent cystidia, and other characters common to this group. See p. 109, 111.

Pholiota subsquarrosa (Fries) Sacc. Syll. Fung. 5: 750. 1887. Reported by McIlvaine. I have seen no specimens so referable, and McIlvaine records that the plants seem different from the European species. See p. 151, 156.

Pholiota terrigena (Fries) Sacc. Syll. Fung. 5: 737. 1887. The species has been reported from the United States but I have seen no material that corresponds to specimens from Bresadola. The plants so recorded should be compared with *P. terrestris* Overholts, which has smaller spores and prominent cystidia. See p. 127.

Pholiota ventricosa Earle is *P. spectabilis* Fries. See p. 146.

Pholiota villosa (Fries) Sacc. Syll. Fung. 5: 752. 1887. Specimens so determined by Peck and similar collections from the Pacific coast seem referable to *P. spectabilis.*

Pholiota washingtonensis Murrill, Mycologia 4: 259. 1912. Seems to be unquestionably *P. ombrophila.* See p. 121.

INDEX TO SPECIES

New species are printed in **bold face** type; synonyms and less important binomials in *italics;* and previously published valid names in ordinary type.

Explanation of Plate

PLATE 8

P. vermiflua. Photo of specimens in Overholts Herb. 3248, × 2/3. Original.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 9

P. praecox. Photo of specimens in Overholts Herb. 3318. Upper half, × 3/5, lower half, × 4/5. Original.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 10

P. Acericola. Photo of specimens in Overholts Herb. 3911, × 3/4. Photo by E. T. Kirk.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 11

P. erebia. Photo furnished by E. T. Harper from plants collected in Michigan. About natural size.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 12

P. aurea. Photo of specimens in Overholts Herb. 8364, collected in British Columbia by J. Schmidt, October, 1922, and communicated by W. S. Odell. Photo by Drayton. Reduced.

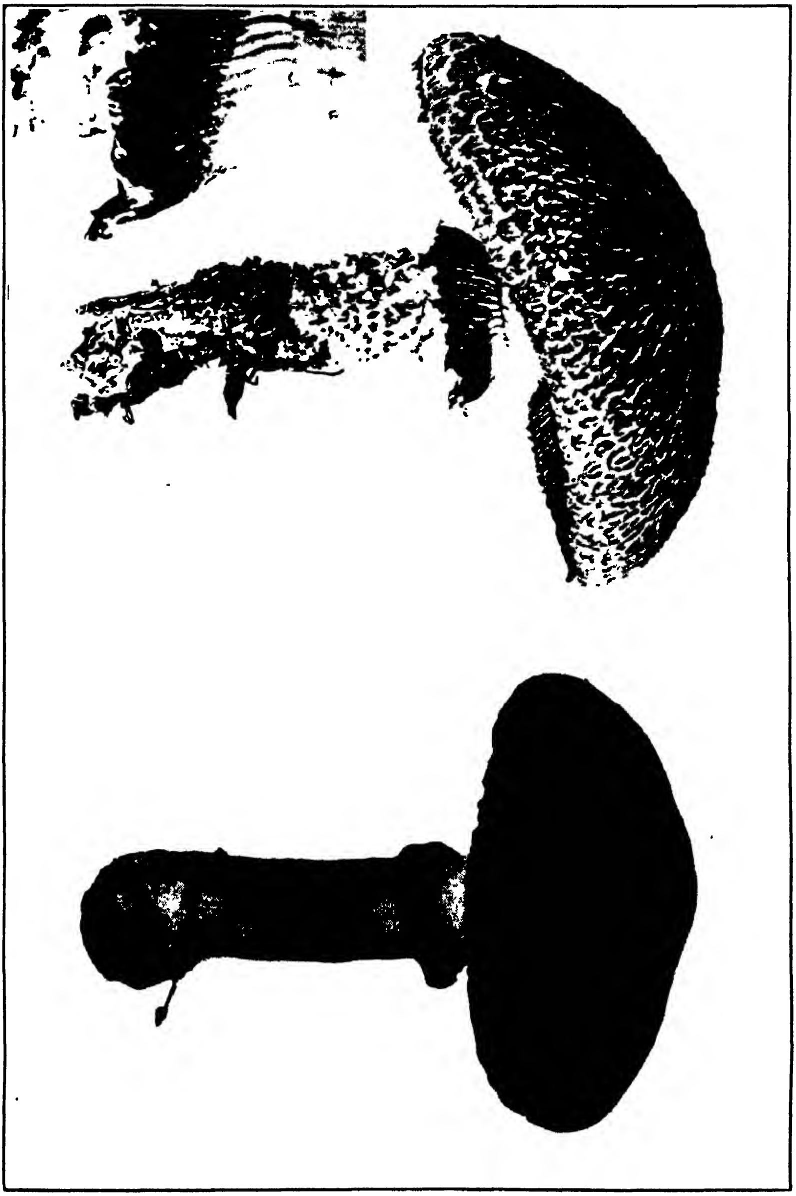
OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 13

P. fulvosquamosa (left half). From Harper, Trans. Wis. Acad. Sci. **17:** *pl. 60.* 1913. About natural size.

P. caperata (right half). Photo of specimens in Overholts Herb. 7967, × 1. Small specimen. Original.



OVERHOLTS—PHOLIOTA IN THE UNITED STATES

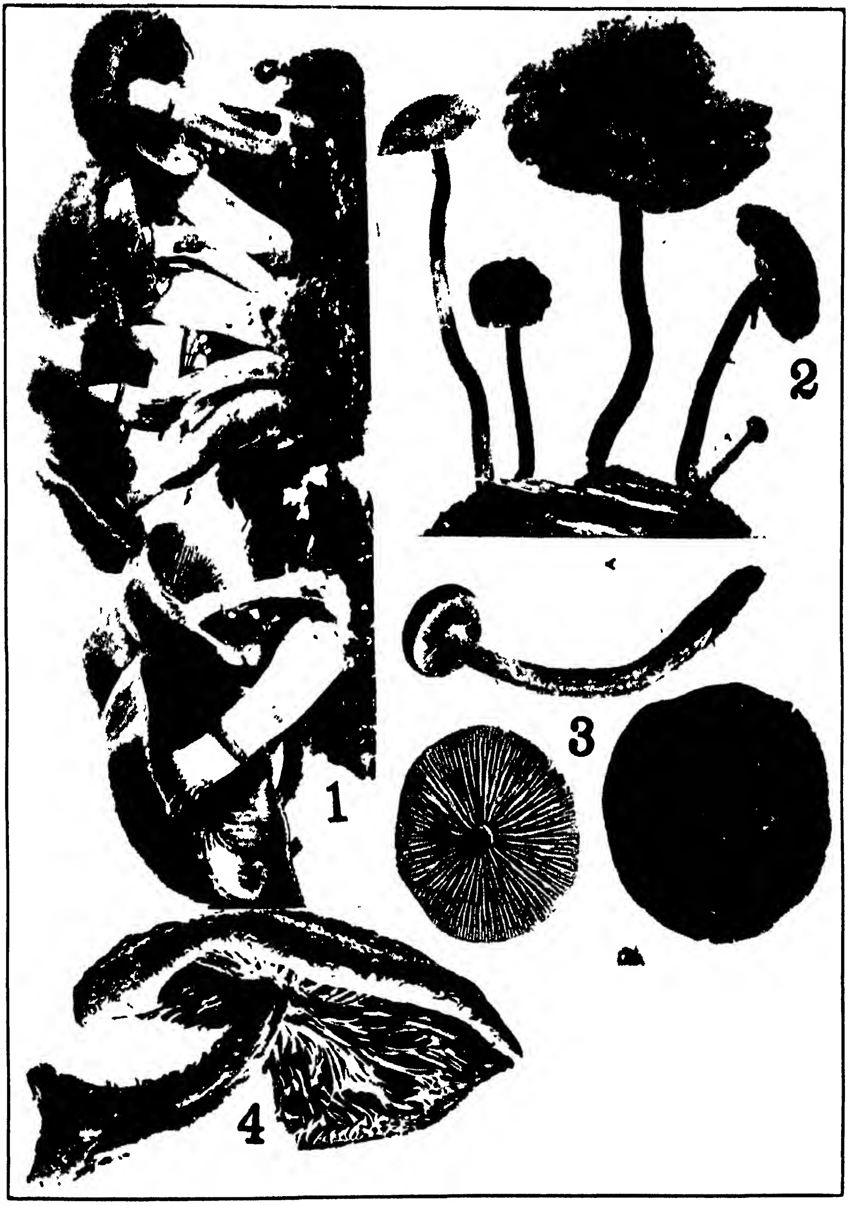
Explanation of Plate

PLATE 14

Fig. 1. *P. marginata.* From Harper, Trans. Wis. Acad. Sci. **17**: *pl. 54, fig. C.* 1912. About natural size.

Figs. 2–3. *P. muricata.* From Harper, Trans. Wis. Acad. Sci. **17**: *pl. 52, fig. A, B.* 1912. About natural size.

Fig. 4. *P. tuberculosa.* From Harper, Trans. Wis. Acad. Sci. **17**: *pl. 41, fig. B.* 1912. About natural size.



OVERHOLTS—PHOLIOTA IN THE UNITED STATES

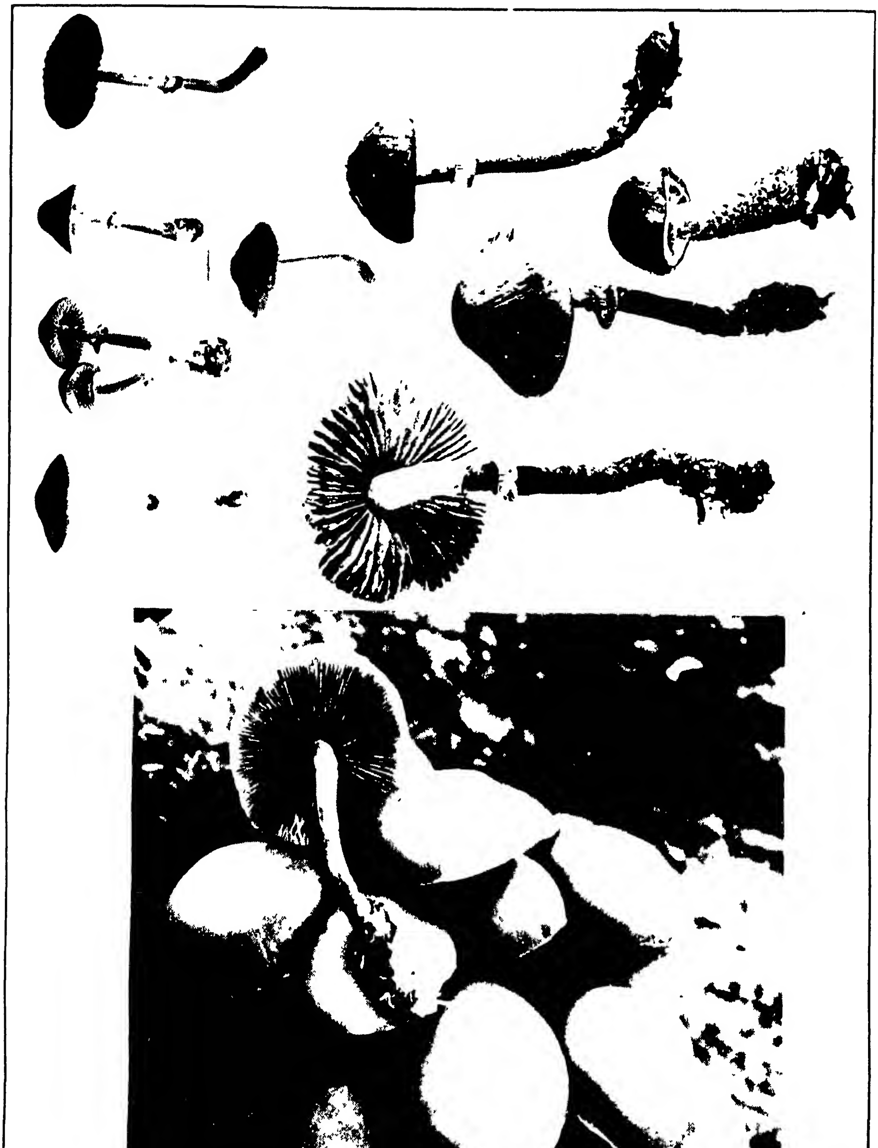
Explanation of Plate

PLATE 15

P. discolor (lower half). Photo of specimens collected in South Boulder Cañon, Colorado, July 18, 1923, elev. 10,000 ft. About natural size. Original.

P. rugosa (upper, left). Photo of specimens in Overholts Herb. 3623, × 1. Original.

P. togularis (upper, right). From Harper, Trans. Wis. Acad. Sci. **17**: *pl. 59.* 1913. About natural size. (Published as *P. blattaria.*)



OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 16

P. spectabilis. Photo of specimens in Overholts Herb. 9889. Reduced somewhat. Photo by L. W. Brownell.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 17

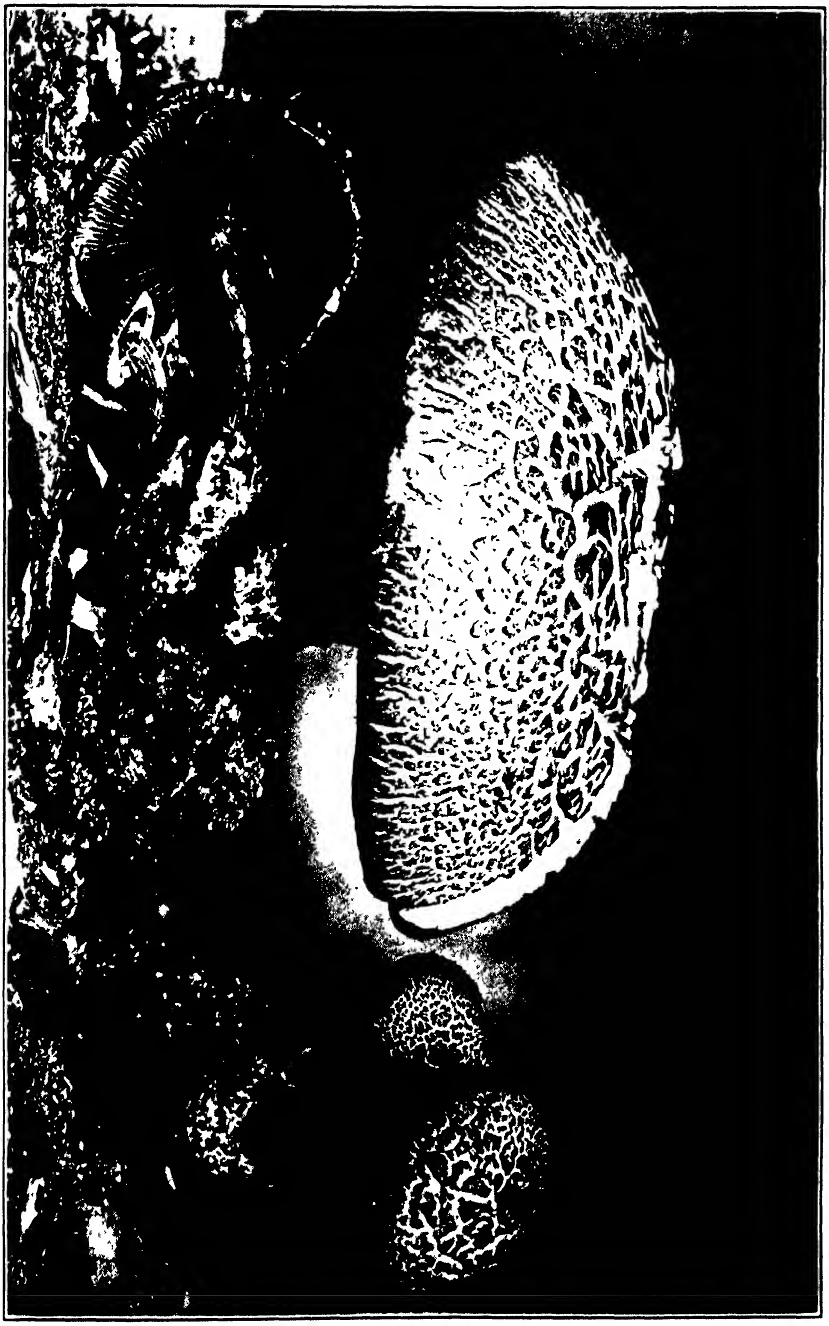
P. spectabilis. Reduced somewhat. Photo by L. W. Brownell.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 18

P. aeruginosa. About natural size. Photo by Burtt Leeper.



OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 19

P. albocrenulata (upper part). From Harper, Trans. Wis. Acad. Sci. **17:** *pl. 42.* 1912. About natural size.

P. flammans (lower part). Right, from Fries, Ic. Hym. *pl. 104, fig. 1;* left, from Harper, Trans. Wis. Acad. Sci. **17:** *pl. 41, fig. C.* Both about natural size.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 20

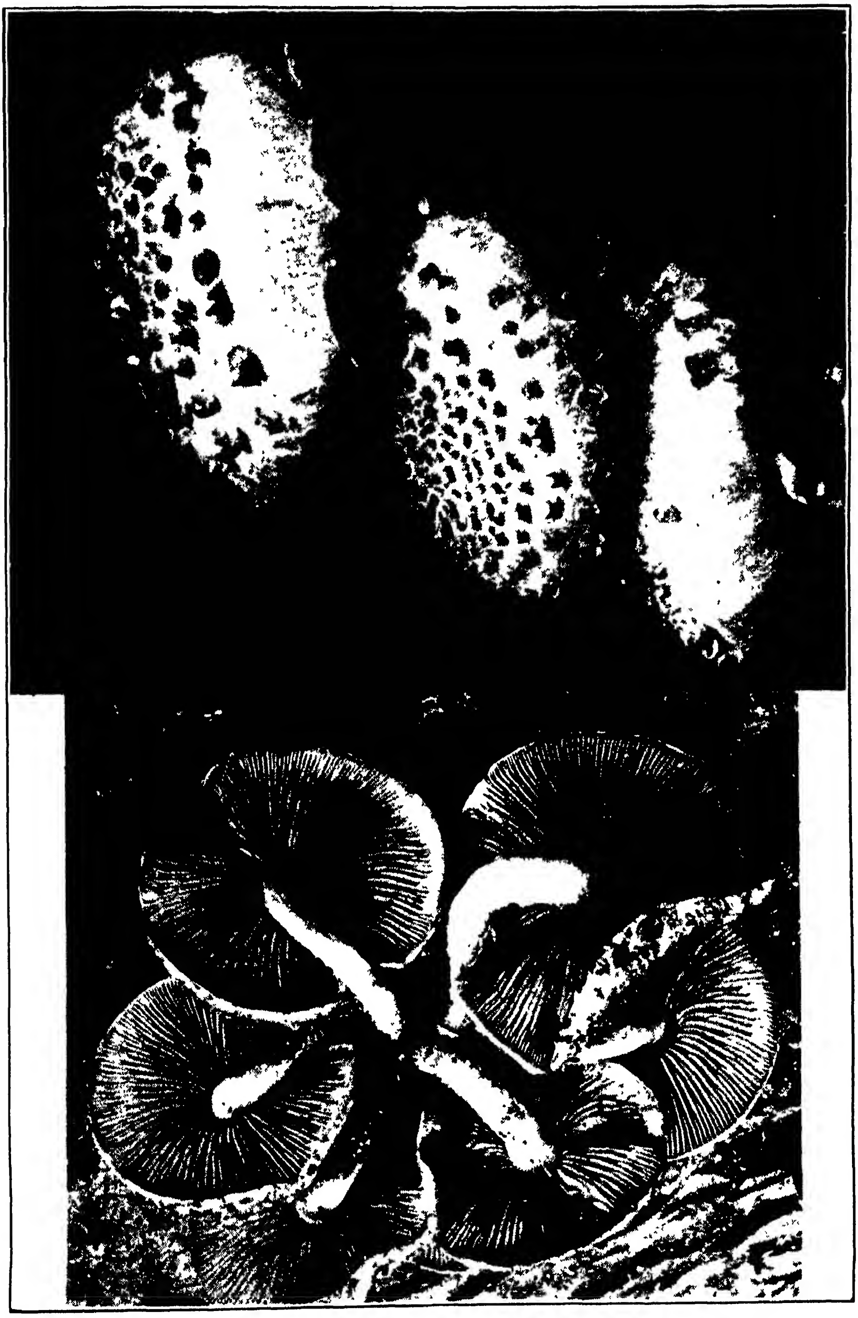
P. adiposa. About natural size. Photo by L. W. Brownell.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 21

P. squarrosa (upper half). About natural size. Photo by L. W. Brownell.
P. adiposa (lower half). About natural size. Photo by L. W. Brownell.



OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 22

P. squarrosoides (large cluster). From Harper, Trans. Wis. Acad. Sci. **17:** *pl. 36.* 1912. Slightly reduced.

P. confragosa (inserts). From Harper, Trans. Wis. Acad. Sci. **17:** *pl. 41, fig. D.* 1912.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

EXPLANATION OF PLATE

PLATE 23

P. angustipes (except lower left corner). From Harper, Trans. Wis. Acad. Sci. **17:** *pl. 34.* 1912. About natural size.

P. confragosa (lower left corner). Perhaps slightly enlarged. Photo presented by E. T. Harper.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Explanation of Plate

PLATE 24

P. aurivella. Somewhat reduced. Photo by L. W. Brownell.

OVERHOLTS—PHOLIOTA IN THE UNITED STATES

Annals
of the
Missouri Botanical Garden

Vol. 14 SEPTEMBER, 1927 No. 3

A MONOGRAPH OF THE SECTION OREOCARYA OF CRYPTANTHA[1]

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INTRODUCTION

The group of plants treated in the present monograph is remarkably characteristic of the Upper Sonoran areas of the Great Basin region, although a few species are native to the eastern foothills of the Rocky Mountains, one or two have penetrated to the Canadian plains and two or three occur in northern Mexico and adjacent Texas. In western Colorado, Utah, Nevada, and southern Wyoming one or more species may be found on almost any barren hillside. Many seem to prefer soils that are so strongly impregnated with mineral salts that few other plants can compete with them. No species seems to be able to tolerate a moist or undrained situation.

These plants are often transient occupants of any habitat. They seem particularly at home on shifting or disturbed soil. A loose hillside or shale outcrop is a favorite locality for the commoner kinds. And yet they are never weeds in cultivated ground—that distinction is reserved for the annual members of the genus. What the factors are that determine this tendency to occupy changing habitats is as yet unknown to the author—one of many ecological problems suggested by the present study.

The members of the section *Oreocarya* are very similar in general appearance. They are usually gray with numerous trichomes and in most cases are beset with harsh bristles that render

[1] Issued October 8, 1927.

[2] Since the receipt of the manuscript of this paper, Dr. Payson passed away on May 15, 1927.

them unpleasant to human hands. As a group, these plants are inconspicuous in a country where inconspicuous plants are the rule. They are at home with various species of *Atriplex*, *Artemisia*, *Astragalus*, *Eriogonum*, *Abronia*, *Lesquerella*, *Physaria*, *Mentzelia*, *Ephedra*, *Townsendia*, and other similar forms. Many are rather regularly associated with the desert juniper (*Juniperus utahensis*) and the pinyon (*Pinus edulis*).

They are plants of the waste lands of the arid west; lands that are waste not because man has abandoned them but because he has never thought them worthy of his attention. From a conventional viewpoint these species are quite unattractive. Even in the largest-flowered species one can scarcely imagine them being gathered for ornamental purposes. They are neither sufficiently bizarre to render them noteworthy, sufficiently troublesome to make them objects of concern, nor common enough near the habitations of men to have merited for them the distinction of a common name.

In spite of the apparent unattractive nature of these plants they are of remarkable taxonomic interest. As a group they are not easily distinguishable by superficial peculiarities but possess technical characters of rather remarkable constancy. The geographical distribution of the species is decidedly interesting. Many are very local, and most conform very closely to natural areas. The present study has shown that this group of plants exhibits phylogenetic tendencies of importance to students of evolution in the flowering plants. Doubtless certain features of their ecological relationships would offer a promising field for further studies.

Phylogeny

I. THE SECTION OREOCARYA

The author finds that the most successful method of attack on any phylogenetic problem comes from comparing closely related forms. Some at least of the species that occupy contiguous areas and differ only by minor characters may be thought to stand in the father-son relationship to one another. Occasionally, even, we may expect to find series of three species that stand in the grandfather-father-son relationship. Various con-

siderations of age, variability, stability of environment, etc. may be expected to influence the nature of the descendants, but it does not seem probable that these disturbing factors will so confuse the phylogenetic pattern as to make it entirely unintelligible. Even if of two, or three, closely related species no one represents exactly the ancestral form it will often happen that one remains more primitive than the other, and consequently the direction of evolutionary change will be quite as evident as though one species had remained stationary while the other diverged. If, by studying closely related forms, it can be discovered which is the ancestor and which the descendant, or which the primitive member and which the specialized one, evidence may be gained for use in building a theory of phylogeny. If one bit of such evidence is consistent with another gained from a consideration of other characters, then the hypothesis gains in stability. In this way, and piece by piece, the evolution of the twigs may be interpreted, and finally by putting all the facts together it may be possible to make a very probable guess as to the evolutionary form of the branch as a whole.

The following examples will make clear how this method has been employed in the present case.

C. Palmeri and *C. Jamesii* var. *multicaulis* are very closely related forms. The differences between them are: (1) *C. Palmeri* lacks a circle of crests at the base of the corolla tube, while in *multicaulis* the crests are very well developed; (2) *C. Palmeri* has a much more conspicuously accrescent calyx than *C. multicaulis;* (3) in *C. Palmeri* the style is longer than in *C. multicaulis* and so also is the corolla tube in proportion to the corolla lobes. One of the best arguments for the derivative nature of any species is the absence of parts that are characteristic of the family to which it belongs. The lack of crests is such a character. Their presence is widespread in the family, and their loss is held to be a reduction pointing the direction of evolutionary change. The presence of accrescent calyx lobes in *Palmeri* strengthens the argument that *C. multicaulis* is a more primitive species than the other. It is now reasonable to suppose that in correlation with these characters, the other differences are significant as showing the course of change.

Another interesting pair of closely related species is *C. oblata* and *C. Jamesii* var. *multicaulis.* These are not so closely related as were the other pair and yet their relationship is quite evident. In the original description of *C. oblata,* M. E. Jones cited a specimen of *C. Jamesii* var. *cinerea* as typical of the new species. In comparing these two we notice the following significant differences:

C. oblata	*C. Jamesii* var. *multicaulis*
Crests lacking at base of tube	Crests present
Corolla tube exceeding the calyx	Corolla tube and calyx subequal
Calyx conspicuously accrescent	Calyx scarcely accrescent
Flowers heterostyled	Flowers uniform
Cymes contracted	Cymes elongating
Nutlets somewhat roughened dorsally	Nutlets smooth dorsally
Indument conspicuously setose	Setae less conspicuous

Following the lead given in the other case *C. multicaulis* may be considered primitive in having crests at the base of the tube and a scarcely accrescent calyx, while *C. oblata* is specialized in these characters. Nor is it unreasonable to think of roughened nutlets being more specialized than smooth ones and conspicuous setae developed later than the less setose trichomes. It now seems probable that the long corolla tube is derived from a shorter one and that heterostyled flowers have been developed from uniform flowers within the genus.

Other examples might be given. *C. confertiflora* and *C. flava* are very closely related and have been confused in the past with *C. leucophaea.* The relationship of these three species is so close that any one of them might be considered the ancestral form or that all three might have come from a very similar common ancestor. The latter supposition is the more probable. The phylogenetic conclusions will not be very different in either case.

C. confertiflora	*C. flava*	*C. leucophaea*
Crests usually evident	Crests usually obsolete	Crests usually evident
Conspicuously heterostyled	Conspicuously heterostyled	Less heterostyled

Nutlets ovate	Nutlets lanceolate	Nutlets ovate
4 nutlets mature	1–2 nutlets mature	3–4 nutlets mature
Flowers yellow	Flowers yellow	Flowers white

On the basis of the absence of crests in the corolla tube it may be concluded that *C. flava* is more specialized than are either of the others. When the data on the number of nutlets that mature are considered (and these data are very meager in the case of *C. leucophaea*) evidence is obtained for a belief in the primitive nature of *C. confertiflora* and *C. leucophaea* as compared with *C. flava*. Since the lanceolate nutlets are found in that form where one or two nutlets quite regularly abort, and the species with ovate nutlets usually mature all of their fruits, it is logical to consider the lanceolate nutlets as derived from the ovate ones because their occurrence in this trio is associated with another character about which there can be no doubt as to the phylogenetic interpretation. *C. leucophaea* seems to be less distinctly dimorphic in flower structure than is *C. confertiflora;* also the corolla tube is not so long, the flowers are white rather than yellow, and the indument less coarse. These are all characters that were thought of as primitive in connection with *C. Jamesii* var. *multicaulis* when contrasted with *C. oblata* and *C. Palmeri*.

It is of interest to make an especial study of those species that lack crests at the base of the tube. These species may be considered as specialized in that regard and since forms that are highly developed in one character may be expected to show recent rather than primitive qualities in other characters, it might be expected that on the whole the characters of this group of species would be specialized. The species that quite regularly lack crests at the base of the tube are: *Palmeri, echinoides, fulvocanescens, flavoculata, Bakeri, oblata, flava, paradoxa, Jonesiana, longiflora,* and *tenuis*. In addition to these, *confertiflora, Osterhoutii, Wetherillii,* and *mensana* have poorly developed crests or at times none at all. In the first group, those species that are usually without crests, all but one have corolla tubes that exceed the sepals. In the second group two have long corollas and two short ones. Considering both groups together, we have fifteen species of which twelve have long corollas and only three short corollas. Nine out

of the fifteen have distinctly heterostyled flowers. These three characters, long corollas, heterostyled flowers, and lack of crests at the base of the tube, were considered specialized when *C. oblata* was compared with *C. Jamesii* var. *multicaulis*. Some evidence has been obtained that confirms the earlier judgment.

If the group of fifteen species listed in the preceding paragraph is examined as to the relationship of the species involved, one interesting fact is evident. These forms are not considered as closely related among themselves. In other words, the group is almost certainly polyphyletic. *C. Palmeri, oblata, confertiflora* and *flava* belong to the series of which *C. Jamesii* is the primitive member. *C. Jonesiana, C. echinoides,* and *C. fulvocanescens* are related to *C. breviflora* in the short-flowered group. The remaining species are possibly closely related to one another but seem far removed from the *breviflora* or the *Jamesii* group. The conclusion seems evident that the fifteen species listed above comprise a highly specialized artificial group selected from several, perhaps three, natural groups. If this is the case, then heterostyly and the long corolla tube have been evolved more than once within the section *Oreocarya.*

The question of the primitive nature of the perennial or annual habit is of much interest. Morphologists, in general, seem to be of the opinion that the perennial and even the arborescent habit is primitive for the Angiosperms. With this generalization the present author is inclined to agree but he believes he has found good evidence for the primitive nature of the annual habit in the Cruciferae. Because of this apparent contradiction the question in the section *Oreocarya* has received particular attention. If *C. Sheldonii* and *C. Bradburiana* are compared, it is noticed that here are two very closely related species, of which one is perennial and the other biennial. The nutlets in the former are distinctly smoother, and consequently more primitive, than in the latter. The geographical location of *C. Bradburiana* on the periphery of the generic range makes it seem reasonable also to consider this species a recent derivative from *Sheldonii*—so recent a derivative indeed, that there are difficulties in the way of according it complete specific independence.

Such arguments as these might be continued to include all the

evidence at hand for the phylogenetic conclusions that have been reached. This, however, seems of rather doubtful value since any who may wish to challenge the conclusions will wish to review the details of specific differences throughout the section. Enough has been given to show the method of attack, and some evidence has been adduced for some of the more important conclusions. Without further justification, the following summary of phylogenetic conclusions will be presented. These generalizations are, of course, only expected to apply to the evolution of the section *Oreocarya* of *Cryptantha.*

1. Smooth nutlets are more primitive than roughened ones.

2. In the course of evolution the nutlets were first roughened on the dorsal surface and finally on the ventral surfaces.

3. The scar in the primitive nutlets was straight and narrow and without an elevated margin.

4. The nutlets of the more primitive species are attached to the gynobase at a lower point than in the specialized species. (This is in agreement with Dr. Ivan Johnston's theory of the phylogeny of the genera of this family—see Contr. Gray Herb. **74**: 14–19. 1925).

5. The ovate nutlets are more primitive than the elongated or lanceolate type.

6. The primitive corollas in this group were uniform and did not exceed the sepals.

7. Heterostyly has apparently been developed a number of times within the section and seems to be regularly associated with long corolla tubes.

8. Crests at the base of the corolla tube were present in the primitive species and have become obsolete in the more specialized ones.

9. The accrescent sepals denote specialized species, and those forms with sepals that enlarge but slightly in fruit are to be considered primitive in this regard.

10. The primitive inflorescence was confined to the upper part of the stem and was composed of conspicuously elongating scorpoid cymes. As development proceeded the cymes became shorter and the inflorescence tended to extend over more and more of the stem.

11. The rather slender unbranched tall stem is considered more primitive than the very stout stem or the short, branched one.

12. An extremely setose indument is thought to be a mark of specialization, and in like manner a very sericeous and uniform covering is a specialization in another direction.

13. The primitive species were perennials and the less enduring forms are specialized.

14. The linear-oblanceolate leaf is more primitive than the broader ovate or spatulate types.

II. THE GENUS CRYPTANTHA AS A WHOLE

A detailed study of each section of *Cryptantha* in which the evolutionary tendencies were traced from species to species and from group to group would prove of very great phylogenetic interest. When that study is made, then, and only then, will it be possible to discuss the phylogeny of the genus in a comprehensive way. However, even with only a superficial knowledge of the genus as a whole, certain conclusions seem certain enough to warrant some discussion of them.

Two of the sections are characterized by the absence of cleistogamous flowers. This is so evidently a primitive character that these two sections, *Oreocarya* and *Krynitzkia*, are considered the primitive sections of the genus. Of these two sections one, *Oreocarya*, is prevailingly perennial, the other prevailingly annual. On this basis, then, *Oreocarya* is to be considered the most primitive of the four. *Oreocarya* differs from *Krynitzkia* also in other ways that are significant. In the former the flowers are mostly large and the cymes are usually bracteate, while in the latter the flowers are usually minute and the cymes usually ebracteate. In *Krynitzkia* the nutlets are often heteromorphic, while in *Oreocarya* the nutlets may not all develop but there is no tendency to heteromorphism. All these differences go to show that *Oreocarya* is, as a whole, more primitive than is *Krynitzkia*. However, the section *Krynitzkia* may not be considered as made up merely of specialized descendants of recent species of *Oreocarya*. For one thing, the elongated cymes, a primitive character, that are so characteristic of *Krynitzkia* must be traced back to a primitive rather than to a specialized *Oreocarya* species or *Oreocarya* ancestor.

The other two sections of *Cryptantha*, *Geocarya* and *Eucryptantha*, are, as it was stated before, characterized by the presence of cleistogamous flowers. In the former these are highly specialized and curious structures from near the surface of the ground, in the latter they occur in the inflorescence or in the axils of the cauline leaves and are not so highly transformed. It seems evident that of the two, *Geocarya* is to be considered the most specialized section of the genus. Both *Geocarya* and *Eucryptantha* have perennial primitive representatives as well as annual specialized ones.

The author interprets these facts concerning the characteristics of the sections as follows:

The perennial species we now place in the Section *Oreocarya* are the most primitive we know in the genus. The most primitive of these is *C. Jamesii* var. *multicaulis*. This variety has so many primitive characters that it may be used to visualize the ancestral form from which the others developed without doing violence to the known facts of phylogeny. It would seem reasonable to suppose that the primitive *Oreocarya* species evolved in four rather distinct directions. The species of *Oreocarya* remained perennial and showed a marked tendency to develop larger flowers and to reduce the length of the cymes. This group is probably monophyletic in the sense that a single primitive species gave rise to several species that in their turn produced others. Development in another direction produced annuals very early in the history of the genus. These annuals showed a marked tendency to reduce the size of the flowers, differentiate the nutlets in a single flower, and to elongate the cymes. This group we now know as the section *Krynitzkia*. It is probably truly polyphyletic, and species grouped here have arisen independently from several perennial ancestors.

The development of cleistogamous flowers of the two kinds undoubtedly began before the perennial habit had been lost since both the sections *Geocarya* and *Eucryptantha* have primitive perennial members. These sections followed lines of development very similar to those of *Krynitzkia* and so the species of these three sections are very similar in appearance. It seems rather doubtful if *Geocarya* is polyphyletic because of the very peculiar

cleistogamous flowers common to the species. *Eucryptantha*, however, may have arisen a number of times from *Krynitzkia*—whenever cleistogamous flowers were developed.

III. THE MECHANISM OF EVOLUTION

It is the author's contention that a taxonomic and phylogenetic study furnishes one of the best backgrounds for an evaluation of various theories of the mechanism of evolution. To make the most of this opportunity the taxonomic-phylogenetic study should be followed by an investigation into the variability, heredity, ecology, etc., of the group of plants under consideration. In the present case this has not been done, and it is realized that any conclusions the author may have reached must be offered merely as suggestions. The following speculations are presented for what they may be worth.

Natural selection.—The species of the section *Oreocarya* are much too beautifully adapted to their surroundings to permit the theory of natural selection to be discarded in any consideration of the evolution of the group. However, when the differences between species are taken into account, it seems evident that natural selection has had little to do with the evolution of species. For example, it is hard to imagine that the difference between the muricate and rugose nutlets would have any survival value. Even the wings on such nutlets as *C. confertiflora* or *C. setosissima* scarcely seem to be large or efficient enough to be of real value to the species. The distribution of pustulate hairs on the surfaces of the leaves can hardly be supposed to determine whether a species will survive or not. Even though specific differentiation in *Oreocarya* may be non-adaptive yet it is quite possible that natural selection has been constantly operative in eliminating many evolving forms that were not nicely adjusted to their surroundings.

Geographical isolation.—The author is inclined to believe that geographical isolation has been one of the chief factors in speciation. The way in which species conform to natural areas in their distribution, the consistency with which closely related and incipient species occupy adjoining areas, and the trivial characters that distinguish species and varieties, all seem to argue in favor

of isolation, and in the present case mainly geographical isolation, as being one of the most important evolutionary factors.

The subject of Age and Area has been much discussed recently. The author can see no indication that there is any correlation between these two factors in the present group of species. The species that is considered most primitive, *C. Jamesii*, occupies the largest area of any species in the section. However, *C. flavoculata*, which is certainly one of the most specialized of all, occupies an area that is much larger than that occupied by most species. Although the comparative ages of the species have not been established, it might be expected that there is a close positive correlation between age and degree of specialization.

Orthogenesis.—The frequency with which orthogenetic explanations lend themselves to phylogenetic description seems to be impressing itself more and more upon those who are interested in evolutionary theories. Orthogenesis is a phenomenon of evolution and no explanation. There is, of necessity, nothing teleological about this mode of development. In the present study one very interesting tendency that may be considered orthogenetic seems to be in operation. This is the tendency for long-lived ancestral species to produce short-lived descendant species. In the section *Oreocarya* this tendency has certainly occurred several times independently although the annual habit has never been attained. The sections *Eucryptantha* and *Geocarya* exhibit the same tendency to reduce the length of life. Therefore, in looking over the genus as a whole it can be said that again and again long-lived species have given rise to shorter-lived ones. Is this an inherently orthogenetic tendency or is it to be interpreted merely as a general response to wide-spread conditions of a common habitat? The only approach to an answer that the author can give to this question at the present time is to call attention to the phylogeny of *Lesquerella*. Here is a genus of comparable size to the section *Oreocarya* that occupies an area, in North and South America, where very similar habitats prevail. In *Lesquerella*, the tendency that appears again and again as the species evolve is to increase the duration of life. In similar, and often identical, habitats two unrelated genera do opposite things: *Cryptantha* produces annuals or biennials again

and again, while *Lesquerella* produces perennials time after time. And yet the tendency is not absolute. At least one species in *Lesquerella*, *L. Cusickii*, has certainly been produced from perennial parents,[1] and it seems quite probable that in South America *Cryptantha argentea* and *C. amplexicaulis* have developed from annual parents.

Geographical Distribution

A careful study of geographical distribution is at once one of the most interesting and necessary parts of any taxonomic or phylogenetic monograph. It is of great interest because species must evolve in some relation to their distribution and theories of isolation are becoming of greater and greater importance. Geographical distribution is of great practical importance in determination of species, since closely related forms rarely exist in the same area.

In a genus previously studied, i.e., *Lesquerella* of the Cruciferae, there was a most interesting direct relationship between geographical distribution and phylogeny. In this case the primitive species are located rather near the center of distribution and the farther any species occurs from this central region the more likely is it to be specialized. In the present group of species, this relationship seems not to hold—or at least not to be conspicuous. The only explanation that suggests itself at present is that the section *Oreocarya* is too old to show such a relationship. In this connection it would be most interesting to study the distribution of the more specialized sections of the genus in order to discover if other relationships exist there.

A study of a map on which are plotted all the specific ranges reveals the fact that the center of distribution is in western Colorado and eastern Utah. A conspicuous area of concentration extends from northeast to southwest, from southern Wyoming to southern Nevada.

If the distribution of the genus *Cryptantha* as a whole is examined it is seen that the primitive section, *Oreocarya*, is confined (if we neglect one or two possible South American species) to

[1]See Payson, E. B. A monograph of the genus Lesquerella. Ann. Mo. Bot. Gard. 8: 104. 1921.

North America, and the most primitive species is in the southern part of the sectional range. The other sections have their most primitive species in South America. It would seem reasonable to suppose that the genus originated in the southwestern part of North America and in its perennial primitive form spread to the desert regions of Chile and Argentina. In that region it became differentiated into three main groups. The most primitive of these invaded North America as *Cryptantha* in the limited sense of recent American floras. The other somewhat more specialized sections have not spread beyond South America. Before any confidence could be placed in such a theory the other sections of the genus would have to be studied very carefully.

The Specific Concept

The attempt has been made in the present study to adopt a specific concept that is intermediate between extremes of segregation and of aggregation although it is recognized that the species are not of uniform value. In general it has been the policy to accept as a species any unit that could be distinguished from related groups by two or more constant differences of significant value, provided that intermediates were lacking between the groups, or that these intermediates were so few as to be considered relatively unimportant. If the differences between different groups are of very small size, or if numerous intermediates exist, then the units concerned are best treated as varieties.

A conservative attitude toward proposed species has been maintained in case the evidence at hand is rather meager. This has led to the retention of certain units as species when possibly they will eventually be accorded varietal rank only.

The author is firmly convinced that all the units that are here accorded taxonomic recognition are real genetic units of considerable size and distinctness. Further study may shift the status of the various groups but this will be only of minor importance.

The device given below has been employed to illustrate the specific concept and, at the same time, to indicate something of the relative value of the different units. It is to be understood that names associated in certain positions in this outline are not indications of new nomenclatorial combinations.

Species and subordinate groups that the author would recognise if a broader specific concept were employed	Species and subordinate groups as recognised in the present study	Species and subordinate groups as they might be recognized if the specific concept were smaller and the presence of intermediates ignored
Jamesii	*Jamesii*	
multicaulis	*multicaulis*	*multicaulis*
	laxa	*laxa*
	cinerea	*cinerea*
	disticha	*disticha*
		Jamesii
typica	*typica*	
abortiva	*abortiva*	*abortiva*
pustulosa	*pustulosa*	*pustulosa*
Palmeri	*Palmeri*	*Palmeri*
oblata	*oblata*	*oblata*
leucophaea		
confertiflora	*confertiflora*	*confertiflora*
flava	*flava*	*flava*
typica	*leucophaea*	*leucophaea*
salmonensis	*salmonensis*	*salmonensis*
stricta	*stricta*	*stricta*
? nubigena	*nubigena*	*nubigena*
Clemensae	*Clemensae*	*Clemensae*
setosissima	*setosissima*	*setosissima*
virgata	*virgata*	*virgata*
humilis		
insolita	*insolita*	*insolita*
virginensis	*virginensis*	*virginensis*
tumulosa	*tumulosa*	*tumulosa*
modesta	*modesta*	*modesta*
typica	*humilis*	*humilis*
? nubigena		
caespitosa	*caespitosa*	*caespitosa*
thyrsiflora	*thyrsiflora*	*thyrsiflora*
? elata	*elata*	*elata*
sericea	*sericea*	
	typica	*typica*
	perennis	*perennis*
? aperta	*aperta*	*aperta*
Bradburiana		
? elata		
? aperta		
rugulosa	*rugulosa*	*rugulosa*
interrupta	*interrupta*	*interrupta*
spiculifera	*spiculifera*	*spiculifera*
celosioides	*celosioides*	*celosioides*
Sheldonii	*Sheldonii*	*Sheldonii*
Macounii	*Macounii*	*Macounii*
sobolifera	*sobolifera*	*sobolifera*
typica	*Bradburiana*	*Bradburiana*
nana	*nana*	
commixta	*commixta*	*commixta*
Shantzii	*Shantzii*	*Shantzii*
	ovina	*ovina*
typica	*typica*	*nana*
cana	*cana*	*cana*
propria	*propria*	*propria*

Species and subordinate groups that the author would recognize if a broader specific concept were employed	Species and subordinate groups as recognized in the present study	Species and subordinate groups as they might be recognized if the specific concept were smaller and the presence of intermediates ignored
fulvocanescens		
breviflora	*breviflora*	*breviflora*
typica	*fulvocanescens*	*fulvocanescens*
echinoides	*echinoides*	*echinoides*
Jonesiana	*Jonesiana*	*Jonesiana*
longiflora		
Wetherillii	*Wetherillii*	*Wetherillii*
typica	*longiflora*	*longiflora*
? tenuis	*tenuis*	*tenuis*
Osterhoutii	*Osterhoutii*	*Osterhoutii*
paradoxa	*paradoxa*	*paradoxa*
Bakeri	*Bakeri*	*Bakeri*
flavoculata		
mensana	*mensana*	*mensana*
typica	*flavoculata*	*flavoculata*
		? cristata
		? Shockleyi

TAXONOMIC CHARACTERS OF SPECIFIC VALUE IN THE SECTION OREOCARYA

Nutlets.—Nutlet differences are remarkably constant between individuals of any species in this group. With rather few exceptions, it is possible to determine any species by means of a mature nutlet. Differences in the character of the surface are most important, although size, form of the scar, and outline are usually characteristic. Were the nutlet peculiarities the only differences that exist, the species would be doubtfully tenable as species. However, when the plants are well known certain other characters are evident that are correlated with nutlet characters as well as with geographical distribution.

Corolla.—Certain differences in the corolla are of great importance. The relative length of the corolla tube and calyx lobes is very constant for any given species. The form of the fornices, the presence or absence of crests at the base of the tube are valuable diagnostic characters. Two species have yellow corollas while all others have white ones. In a few the corolla tube is pale yellow. In most species the fornices are distinctly yellow.

Calyx.—The sepals offer a few valuable characters. The amount of elongation of the lobes after anthesis is comparatively

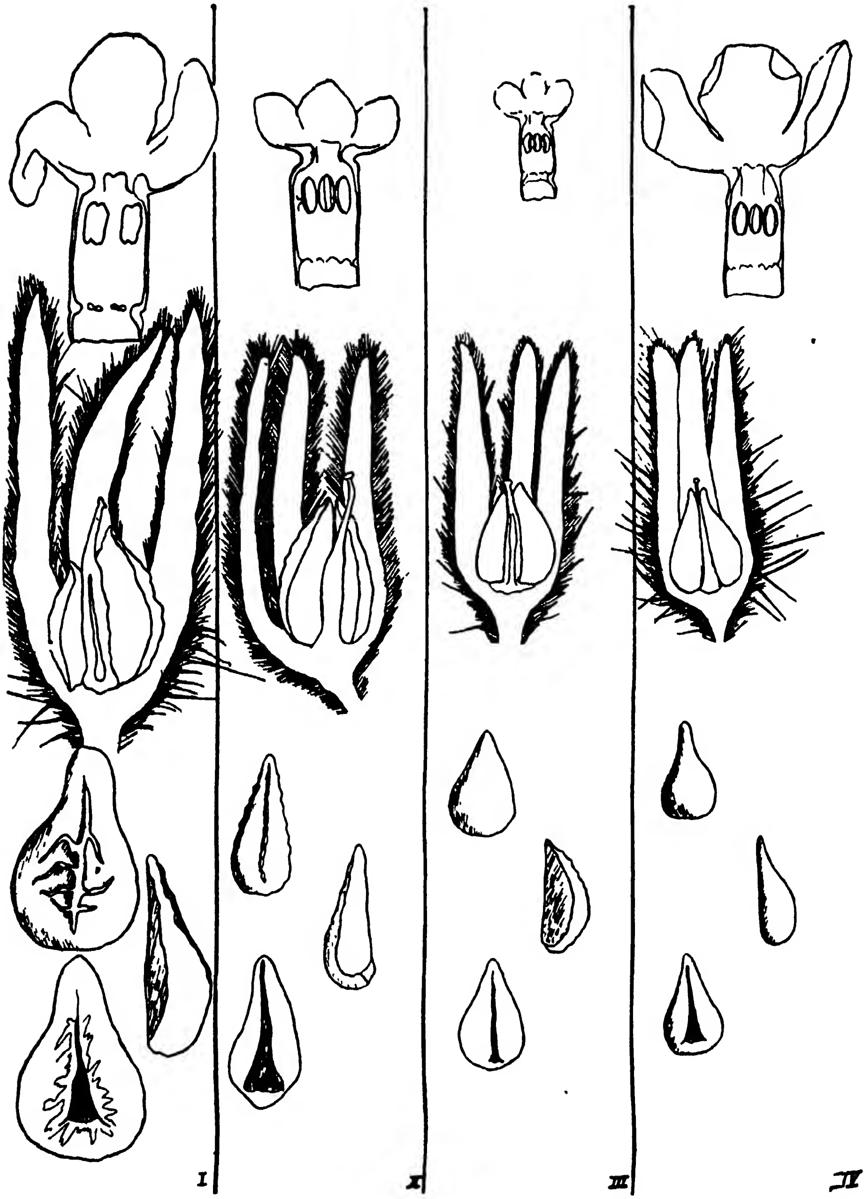

Fig. 1. Comparison of floral and fruit details of four species of *Cryptantha*: I. *C. virginensis*, section *Oreocarya*; II. *C. capituliflora*, section *Eucryptantha*; III. *C. Kingii*, section *Geocarya*; IV. *C. ambigua*, section *Krynitzkia*.

small in a few primitive species. Certain species have sepals that are nearly linear and in others they are fairly broad.

Style.—The length of the style, as well as the position of the stamens in the corolla tube, is of little specific value in the long-flowered species, since most of them are distinctly dimorphic in these characters. In the short-flowered species, however, the distance that the style exceeds the mature nutlets is of some value.

Indument.—Some species are characteristically setose and others conspicuously sericeous but most of the different forms are so similar in general hairiness that the differences are unnoticed by any one unfamiliar with the group. A few species are nicely characterized by the absence of pustulate hairs on the upper leaf surface, and one is peculiar in being nearly glabrous.

Inflorescence.—Differences in inflorescence are difficult of description. Most of the species are similar with respect to the manner in which the flowers are borne. A few have an unusual appearance because of the regular and extreme elongation of the cymes. One, *C. virgata*, is unique in the possession of elongated foliar bracts in an otherwise narrow inflorescence. Most of the species with a narrow inflorescence have a tendency to elongate the branches in age and so come to resemble those species with characteristically broad inflorescence.

Persistence.—A few of the species are evidently biennial and some are especially long lived. In general, differences in duration are not easy of definition and interpretation, and so these characters are only of exceptional value.

Leaves.—Leaf size and shape vary considerably between individuals and are ordinarily of little value in identification.

Stem.—Most of the species are similar with respect to the characters of the stem. A few are unusually tall and some are very low and caespitose.

Gynobase.—This structure is difficult of examination and in only a few species is it of diagnostic value. A series of careful drawings of the gynobase was made and these are available in the Rocky Mountain Herbarium.

The Generic Concept

One of the most important results of the present study has developed from a suggestion made to the author early in 1924 by Dr. Ivan Johnston of the Gray Herbarium. This was to the effect that *Oreocarya* could only with difficulty be maintained as a genus separate from *Cryptantha*. Since that time Dr. Johnston has continued his studies of the genera of this family and has become convinced that his earlier conjecture was correct. He has studied and collected plants of this relationship in South America as well as in western North America and has accumulated much evidence bearing on this point. Through the kindness of Dr. Johnston and of Dr. B. L. Robinson of the Gray Herbarium the author has been permitted to study a considerable series of South American specimens. This study, although much more superficial than that given to it by Dr. Johnston, has served to confirm his conclusions and to convince the author that as a genus *Oreocarya* can not be separated from the older *Cryptantha*.

In this enlarged sense, *Cryptantha* consists of about 150 species of the arid regions of western North and South America. These species are annual, biennial, perennial or even fruticose herbs with linear, oblanceolate, spatulate or nearly obovate leaves. Most of the species are clothed with a conspicuous indument of unbranched trichomes and all possess some enlarged epidermal pustules. The inflorescence consists of variously elongating, 2-ranked, scorpioid cymes. The sepals are persistent and usually somewhat accrescent in fruit. The corolla is salverform and white, white with yellow fornices, or entirely yellow in color. The fornices are always present at the throat of the corolla tube; a circle of crests at the base of the tube is present or absent. Nutlets are homomorphous or heteromorphous, one to four maturing, straight or nearly so, attached laterally to a subulate gynobase, smooth or variously roughened.

The considerations that have led the author to submerge *Oreocarya* into *Cryptantha* may be summarized as follows:

FUNDAMENTAL PREMISES

1. Genera can not be maintained that are only provincially distinct. In other words, genera should not be recognized in

one part of the world if they are not satisfactorily distinct in another.

2. It is admitted that genera are partly limited by a consideration of matters of convenience but fundamentally there must be some morphological character or characters on which to base genera.

3. If genera are based entirely on considerations of convenience, then taxonomic groupings will become so artificial and distorted as to furnish no sound basis for geographic or phylogenetic generalizations and taxonomy will become no more than a system of cataloguing.

4. Habital differences only may be of great value in specific or varietal distinctions but are not usually of generic value. Furthermore it is easy to say that this group differs from that in aspect but if this difference in aspect is not capable of morphological definition it can be accorded very little weight.

IMMEDIATE CONSIDERATIONS

5. The species of *Cryptantha* in South America, maintained by Johnston as valid, are about 40 in number. These include forms with considerable diversity of structure. There are forms with cleistogamous flowers of various kinds, others with only chasmogamic ones. There are fruticose, persistent, and annual species. However, the intermediates are so evident between the various categories that there seems no possibility of separating them except specifically. In South America, then, we have one genus.

6. It seems quite impossible to separate the annual North American Cryptanthas from the annual South American species except specifically. Some forms from the two continents are so similar that they could even be confused as belonging to the same species.

7. There are in South America a few species which in North America would unhesitatingly have been referred to *Oreocarya* because of floral and fruit characters as well as characteristic habit and aspect. These species are not aberrant Cryptanthas in South America.

8. The author has found it impossible to locate a single morphological character that will definitely separate *Oreocarya* and

Cryptantha when the South American species are taken into account. Even in North America the only character that has been found that will separate the two groups is the biennial or perennial root in *Oreocarya* and the annual one in *Cryptantha.*

9. From a standpoint of geographical distribution it is not remarkable to find a single genus common to western North America and western South America in Chile and Argentina. Many examples might be given: *Lesquerella mendocina* of northern Argentina, adjacent Chile and Bolivia is so similar to certain Rocky Mountain species as to make determination difficult if the labels are concealed; *Coldenia Nuttallii* is common to both continents with an enormous gap between (see Johnston, Contr. Gray Herb. 75: 43–44. 1925); *Atamisquaea emarginata* is common to Lower California and to Chile.

If only the North American species were concerned, the author would keep the genera *Oreocarya* and *Cryptantha* as distinct on the basis of annual as opposed to perennial or biennial herbs. In addition, the inflorescence of *Cryptantha* is usually elongated and bractless while that of *Oreocarya* is usually contracted and bracteate. There are, however, many exceptions to these distinctions. The nutlets in the North American Cryptanthas show a strong tendency to definite heteromorphism, while in *Oreocarya* no such tendency has been noted. There are North American Cryptanthas with homomorphous nutlets. In some species of *Cryptantha* the calyx tends to fall as a unit and enclose the persistent nutlets. This has been given as a character distinguishing *Oreocarya* from *Cryptantha* but is not satisfactory, since many Cryptanthas do not shed their calyces and in one *Oreocarya,* at least, the pedicels have a tendency to separate from the stem and so drop the calyx with the persistent nutlets. This is *C. nana* var. *commixta.* Taking the South American species into consideration then, the one definite character separating *Cryptantha* from *Oreocarya* disappears entirely, and the union of the two groups becomes a necessity if the premises given above are worthy of acceptance.

The unfortunate result of uniting the Oreocarya group with the Cryptanthas comes because of the necessary shift in names. This seems unavoidable and is in the direction of simplification

rather than of complication. There has been much demand of late, on the part of taxonomists as well as non-taxonomists, for larger generic concepts and a consequent reduction in generic names. And it therefore happens that the change necessary in the present case is in line with tendencies that cannot be ignored.

Dr. Johnston (Contr. Gray Herb. **74**: 1–114. 1925) has reviewed the historical development of the genus *Cryptantha* (exclusive of *Oreocarya*) and has discussed the question of segregation and available generic names. This material need not be repeated here. Suffice it to say that the author accepts this treatment of the genus in North America as regards generic concept but would now add to it *Oreocarya*.

Taxonomic History of the Section Oreocarya

The first species belonging to this group to be described was *C. Bradburiana*. This was collected by Bradbury in "Upper Louisiana" in 1810 and described by Pursh as a species of *Cynoglossum* in 1814. In 1818 it was transferred to *Myosotis* by Nuttall. In 1828, a second species was described (*C. Jamesii*) and assigned to *Myosotis* by Torrey. Douglas described the third species (*C. leucophaea*) in 1830 and also placed it in *Myosotis*.

De Candolle in the 'Prodromus' transferred *Bradburiana* and *leucophaea* to the genus *Eritrichium* in 1846 and so started a treatment that persisted until 1885. During this period four species and two varieties were described in the group. The most important publication affecting the genus was by Gray in Proc. Am. Acad. **10**: 61. 1875. As a part of a revision of *Eritrichium* Gray grouped the known species and varieties together under the section *Pseudo-Myosotis* which had been proposed by A. De Candolle in the 'Prodromus' for *C. leucophaea*. Four species and three varieties were recognized as valid in this revision.

The next important treatment of this genus was by Gray in Proc. Am. Acad. **20**: 276–280. 1885. The species are here transferred to the section *Pseudokrynitzkia* of *Krynitzkia* with the exception of *C. setosissima* which was placed in the section *Pterygium*. The group was still held essentially as a unit and eight species were recognized that are now placed in the section *Oreocarya*.

The genus *Oreocarya* was proposed by Greene in 1887 (Pittonia 1: 57–58) and made to contain nine species—eight of which are now held in this section. It is evident that this paper of Greene's is concerned with the question of the generic relationship of certain Boraginaceous plants rather than with specific determinations, since the species are those recognized by Gray as of this relationship in 1885. In 1896 Greene again published on this genus, and this time it was to describe eight new species and to redescribe several old ones. With this paper, Greene's most important contributions to the study of this genus end. In 1899 he described two new species and in 1901 two more.

The period from 1896–1915 is chiefly characterized by the appearance in literature of some thirty-five species proposed as new. These were proposed by a number of workers on the flora of the Rocky Mountains and the Great Basin, and except for those described by M. E. Jones were all assigned to the genus *Oreocarya*. The most active in this work of characterizing new species were Alice Eastwood, Aven Nelson, P. A. Rydberg, and M. E. Jones. In 1906 Rydberg published his 'Flora of Colorado' in which he recognized nineteen species as occurring in Colorado alone, and in 1909 Aven Nelson in the Coulter-Nelson 'Manual of the Flora of the Central Rocky Mountains,' maintained the same number of valid species for the whole region covered by the 'Manual.'

The first comprehensive revision of the group as included in the genus *Oreocarya* was published by J. F. Macbride in Contr. Gray Herb. 48: 20–38. 1916. In this very excellent study forty-five valid species are maintained and differentiated by means of a dichotomous key. Specimens are cited under each specific name and comments are made relative to the different species. In 1918 Rydberg published a treatment of the species of the Rocky Mountain region in his 'Flora of the Rocky Mountains and Adjacent Plains.' In this he follows Macbride very largely but recognizes a few species that Macbride had not accorded specific rank. There are a few extra-limital species that Rydberg does not consider. However, he recognizes thirty-nine species in the range of his flora.

The history of *Oreocarya* subsequent to the important work done by Macbride in 1916 has been comparatively unimportant.

New species have been described from time to time by Osterhout, Brand, and Payson. The generic acceptance of *Oreocarya* has been almost universal since the genus was proposed until the present time. M. E. Jones and K. Brandegee seem to have been the only recent taxonomists who have refused to accept the generic separation of the perennial American forms (*Oreocarya*) from the annual species (*Cryptantha* or *Krynitzkia*). Their refusal to accept this segregation, it is of interest to note, was not based upon the most convincing evidence, i.e. the South American material, but upon the similarity of the North American species.

What the author believes to be the beginning of a new concept in the taxonomic treatment of the plants under consideration was made by Dr. Johnston in Contr. Gray Herb. **70**: 46. 1924, when he questioned the generic value of the Oreocarya group.

In summary, the history of this group may be said to reflect the history of taxonomy in America. First we notice the great increase in the number of described species. From two in 1828 the group has grown to eight in 1887, sixteen in 1896, sixty-two in 1916, and seventy-five in 1926. This increase shows two great factors at work. First is the great activity in exploration and description of species from the desert regions of western North America. Second is a tendency to reduce the value of a species. The generic shifts in the position of the species under consideration reflect another phase of taxonomic history. In the earlier treatments the species were placed under older genera to which they were not closely related. These associations proved unsatisfactory and so the species shifted until in *Krynitzkia* Dr. Gray thought he had associated them with their relatives—and so we think to-day. The author thinks there is no doubt but that Dr. Gray would have united *Krynitzkia* with *Cryptantha* if he had known the South American species as we now know them. This earlier period of taxonomic activity—ending with the work of Gray and Watson—was characterized by synthetic studies. Genera were revised as a whole and a great effort was made to arrange the groups so they might stand in the proper relationship to one another. Following this early period came a time of great expansion of population in the United States, and this was followed by a flood of floristic works on the plants of the regions so

newly occupied and colonized. Floras and manuals are notoriously provincial in their generic and specific concepts and so a great impetus was given to segregation of genera and species. Units were maintained in one region that could not be separated in another and there resulted a great confusion in the taxonomy of the plants of western America. This period of regional floras rather than of monographic work on whole genera or families seems now to be giving way to a period of synthetic and even experimental taxonomic work. With the great activity in the botanical exploration of South America, botanists must come to recognize that a local view of a genus is not sufficient and that before species or genera can be successfully characterized they must be seen in relation to all of their relatives. The union of *Oreocarya* and *Cryptantha* is a result of a larger systematic viewpoint and seems inevitable when such an enlarged view is obtained.

Illustrations

Since the nutlets present characters of the greatest taxonomic value, and since they are difficult of adequate description, it was thought worth while to illustrate all of those species in which the nutlets are significantly different. These drawings were made in pencil from the nutlets as seen through a binocular dissecting microscope giving a magnification of thirty diameters. Each nutlet is shown in three positions, and all were drawn twenty times the actual size. In reproduction this enlargement was reduced one-half. All the illustrations were prepared by the author.

Acknowledgements

The author is under great obligations to many people for assistance in the present work. Any taxonomic treatment borrows much from earlier workers. Sources of this kind are indicated in a bibliography. In the present case the revision by Mr. J. F. Macbride has been of the greatest value. That was the pioneer work that assembled the materials and made the present study much less difficult than it would otherwise have been. To Dr. Ivan Johnston and Dr. A. Brand the author is much indebted for

suggestions concerning the plants under consideration. Both of these workers are at present busied with studies in the *Boraginaceae*. Dr. Aven Nelson, Curator of the Rocky Mountain Herbarium, has done much to encourage and assist the author in many ways.

Herbarium material has been borrowed from a number of herbaria. Some collections have been visited by the author in person. To the curators of these various herbaria the author wishes to express his gratitude.

To Dr. George T. Moore, Director of the Missouri Botanical Garden, and to Dr. J. M. Greenman, Curator of the Herbarium at that institution, the author is under especial obligations for making possible the publication of this paper.

Specimens have been examined from the following herbaria, the abbreviations in parentheses being those used in the citation of specimens:

1. Colorado State Museum (Colo.).
2. Field Museum (Field).
3. Gray Herbarium (Gray).
4. Missouri Botanical Garden (Mo.).
5. Montana State College (Mont.).
6. New York Botanical Garden (N. Y.).
7. George E. Osterhout Herbarium (Osterh.).
8. Philadelphia Academy of Natural Sciences (Phila.).
9. Pomona College (Pomona).
10. Rocky Mountain Herbarium (R.Mt.).
11. United States National Herbarium (U.S.).
12. University of California (Calif.).
13. Victoria Memorial Museum, Ottawa (Canada).
14. Washington State College (Wash.).

Taxonomy

Dr. Ivan Johnston would divide the genus *Cryptantha* into three sections based upon the character of the flowers. To these three, the present author would add a fourth by dividing one of those maintained by Dr. Johnston. This classification may be indicated as follows:

Plant producing only chasmogamic flowers.
Perennial or biennial herbs, native to North America....Section I. *Oreocarya.*
Annual (or rarely perennial) herbs, native to North and South America ....Section II. *Krynitzkia.*
Plant producing some cleistogamic flowers.
Cleistogamic flowers not highly specialized, differing from the chasmogamic ones merely in the closed corolla; borne in the axils of the cauline leaves and frequently in the spikes above..............Section. III. *Eucryptantha.*
Cleistogamic flowers highly specialized, becoming lenticular structures borne at the base of the stem...........................Section IV. *Geocarya.*

The author proposed to retain *Oreocarya* as a section of *Cryptantha* for the following reasons:

1. The group of species that has been treated as comprising the genus *Oreocarya* is a fairly homogeneous unit rather easily separable from the other sections of the genus.
2. That it is not entirely and consistently separable from the other sections is an argument for its reduction from generic rank but is not a reason for failing to recognize it as a section.
3. As a matter of convenience, it is desirable to retain a name that has been so completely incorporated into literature as has *Oreocarya*. Since it can not be maintained as a genus, it is of some value to retain it in subgeneric rank.

In the present treatment the section *Oreocarya* is limited to the North American species. It is recognized that this is a more or less arbitrary division, and it might be argued that the separation would be better made to include all the perennial species without cleistogamic flowers. This would result in including at least one South American species, *C. gnaphalioides*, in the section *Oreocarya.* Two others might also be included, namely *C. argentea* and *C. amplexicaulis.* These two last ones are apparently more nearly related to some of the annual rather than to the perennial species and so would introduce an anomalous element into the section. The author believes that because the sectional separation must be made more or less arbitrarily, since no distinct line of cleavage exists, it is well to make it conform to distinct geographical lines. This seems particularly desirable since it is probable that even *C. gnaphalioides*, which species has the best right to be included in *Oreocarya* of all the South American forms, is probably more closely related to the annual Krynitzkias than to the perennial North American Oreocaryas. If it were certain

that a perfectly phylogenetic classification would result from dividing the sections strictly according to morphological characters, then there would be no question as to the preferable procedure. As it is, the sections are convenient, mainly monophyletic, groups, and the question of expediency has a right to consideration.

CRYPTANTHA section OREOCARYA (Greene) Payson new comb.

Eritrichium, section *Pseudomyosotis* A.DC. Prodr. **10:** 129. 1846; Gray, Proc. Am. Acad. **10:** 61. 1875; Benth. & Hook. Gen. Pl. **2:** 850. 1876; Gray, Syn. Fl. N. Am. 2^1: 196–197. 1878.

Krynitzkia, section *Pterygium* Gray, Proc. Am. Acad. **20:** 276. 1885, in part.

Krynitzkia, section *Pseudokrynitzkia* Gray, Proc. Am. Acad. **20:** 276–280. 1885, in large part; Coulter, Manual Rocky Mt. Region, 164. 1885.

Oreocarya Greene, Pittonia **1:** 57–58. 1887; *Ibid.* **3:** 109–115. 1896; Gürke in Engl. & Prantl, Nat. Pflanzenfam. IV. Abt. 3a & 3b. 109. 1897; A. Nelson, Erythea **7:** 65–68. 1899; Howell, Fl. Nw. Am. 486. 1900; Eastwood, Bull. Torr. Bot. Club **30:** 238–246. 1903; Britton, Manual, ed. 2, 770. 1905; Piper, Contr. U. S. Nat. Herb. **11:** 481–482. 1906; Rydb. Fl. Colo. 287–288. 1906; A. Nelson in Coulter & Nelson, Man. Cent. Rocky Mts. 416–419. 1909; Britton & Brown, Ill. Fl., ed. 2, **3:** 80. 1913; Wooton & Standley, Contr. U. S. Nat. Herb. **19:** 544–546. 1915; Macbride, Contr. Gray Herb. **48:** 20–38. 1916; Rydb. Fl. Rocky Mts. 719–725. 1917; Tidestrom, Contr. U. S. Nat. Herb. **25:** 457–460. 1925; Payson, Univ. Wyo. Publ. Bot. **1:** 164–171. 1926.

Perennial or biennial herbs with a conspicuous setose, hirsute or sericeous indument (except in *C. pustulosa*). Leaves entire, oblanceolate, spatulate or linear. Stems solitary from the root or caespitose, commonly unbranched below the inflorescence, 0.5–9 dm. high. Inflorescence a continuous or glomerate cluster of elongating or reduced, simple or branched, bracteate or nearly ebracteate, two-ranked, unilateral, scorpioid cymes. Sepals distinct, usually conspicuously accrescent. Corollas white or yellow, salverform; limb 4–12 mm. broad; tube equalling or ex-

ceeding the sepals. Stamens included in the tube, anthers sessile or nearly so. Style equalling or much exceeding the mature nutlets; stigma entire. Nutlets from nearly circular in outline to narrowly lanceolate, margined or winged, smooth or variously roughened on the different surfaces, attached to the gynobase at a point $^1/_3$–$^4/_5$ of the distance from the base to the apex of the nutlet. Scar of nutlets various, open or closed and margin elevated or plane. Generic type: *C. Bradburiana* Payson.

Artificial Key to the Species of Cryptantha, Section Oreocarya

a. Tube of the corolla distinctly longer than the calyx lobes in anthesis.
  b. Nutlets smooth on the dorsal and ventral surfaces; leaves linear-oblanceolate, usually acute, densely appressed-strigose, petioles ciliate.
    c. Corollas yellow, individuals distinctly dimorphic as regards stamen insertion; species ranging from central Wyoming south and west to southern California.
      d. Nutlets broadly ovate in outline, distinctly wing-margined, all four usually maturing; inflorescence distinctly glomerate; native from Utah to southern California .... *5. C. confertiflora*
      dd. Nutlets lanceolate in outline, scarcely wing-margined, some usually aborting; inflorescence scarcely glomerate; native from central Wyoming through western Colorado to northern New Mexico and eastern Utah .... *6. C. flava*
    cc. Flowers white; individuals less evidently dimorphic as regards stamen insertion; native to Washington and (?) Oregon .... *7. C. leucophaea*
  bb. Nutlets more or less roughened or wrinkled on dorsal surfaces; leaves various.
    c. Nutlets uniformly muricate or papillose, not evidently tuberculate, rugose or wrinkled.
      d. Leaves silky-strigose, pustulate hairs small or lacking; fornices elongated.
        e. Muriculations usually acute and sometimes minutely setose; eastern Utah, adjacent Colorado to northern New Mexico and northeastern Arizona .... *36. C. fulvocanescens*
        ee. Muriculations conspicuously setose, sometimes almost arborescent; southern and southwestern Utah and adjacent Arizona. .... *37. C. echinoides*
      dd. Leaves appressed-setose and coarsely strigose, conspicuously pustulate on both leaf surfaces; fornices low and rounded. .... *38. C. Jonesiana*
    cc. Nutlets more or less rugose or tuberculate, sometimes conspicuously muricate also.
      d. Inner or ventral surfaces of the nutlets smooth or nearly so; margin evidently but rather narrowly wing-margined .... *4. C. oblata*

dd. Inner surfaces of the nutlets distinctly roughened.
e. Nutlets conspicuously muricate, some of these confluent into rugae; scar narrow, straight, open, no indication of an elevated margin..*38. C. Jonesiana*
ee. Nutlets rugose or tuberculate, these more conspicuous than the murications; scar various, margin distinctly elevated in some species.
f. Margins of the nutlets not in contact, fruit oblate-ovoid; densely caespitose perennials; pustulate hairs lacking on upper leaf surfaces..................................*43. C. paradoxa*
ff. Margins of the nutlets in contact.
g. Scar of the nutlets conspicuously open and surrounded by a definite elevated margin....................*46. C. flavoculata*
gg. Scar of the nutlets closed or slightly open but then not surrounded by a definitely limited and conspicuous elevated margin.
h. Leaves sparsely if at all pustulate ventrally, even in age.
i. Scar of the nutlets surrounded by an elevated margin but tightly closed, leaves oblanceolate or broader.*44. C. Bakeri*
ii. Scar neither tightly closed nor surrounded by an evident elevated margin.
j. Leaves narrowly linear-spatulate, nutlets sharply and deeply rugose.........................*41. C. tenuis*
jj. Leaves obovate or broadly oblanceolate; nutlets with rounded rugae and tubercles; fornices long-papillose. ....*39. C. Wetherillii*
hh. Leaves conspicuously pustulate ventrally, especially in age; corolla tube 1 cm. or more long; Colorado..*40. C. longiflora*
aa. Tube of the corolla equalling or shorter than the calyx lobes in anthesis.
b. Nutlets smooth on the dorsal surfaces, not rugose, muricate or tuberculate.
c. Fruit depressed, globular, nutlets not in contact by their margins.
d. Leaves conspicuously pubescent on both surfaces.
e. Crests at base of corolla tube conspicuous; calyx not conspicuously accrescent..................................*1. C. Jamesii*
ee. Crests at base of corolla tube obsolete; calyx conspicuously accrescent...*3. C. Palmeri*
dd. Leaves glabrous above, sparingly hairy below...........*2. C. pustulosa*
cc. Fruit conical or ovoid, nutlets in contact by their margins.
d. Stout, strictly erect plants with many elongated and conspicuous bracts in the inflorescence; eastern Colorado and southeastern Wyoming...*13. C. virgata*
dd. Smaller, somewhat caespitose plants with few or inconspicuous bracts in the inflorescence; central Idaho............*8. C. salmonensis*
bb. Nutlets more or less roughened (muricate, wrinkled, tuberculate), at least on the dorsal surfaces.
c. Nutlets densely and uniformly muricate, not rugose or tuberculate.
d. Pubescence of leaves silky-strigose or strigillose but not subtomentose.

e. Leaves nearly or quite uniformly silky-strigose.
f. Plants scarcely or only moderately caespitose; leaves broadly oblanceolate or spatulate; native to northeastern Utah and adjacent Colorado (?) .... *35. C. breviflora*
ff. Plants densely caespitose, caudex multicipital; leaves linear-oblanceolate; native to eastern Wyoming and adjacent Nebraska and Colorado .... *33. C. cana*
ee. Leaves with two distinctly different kinds of trichomes .... *32. C. nana*
dd. Leaves distinctly subtomentose as well as appressed-setose .. *32. C. nana*
cc. Nutlets not exclusively muricate.
d. Inner surfaces of the mature nutlets smooth or nearly so, not conspicuously rugose, tuberculate or muricate.
e. Nutlets ovate, papery with a broad, thin wing-margin; stout, erect plants 2.5–8 dm. tall; native to Utah and Arizona .... *12. C. setosissima*
ee. Nutlets ovate to lanceolate, not with a broad, thin wing-margin if the nutlets are ovate in outline.
f. Stout, strictly erect plants with many elongated and conspicuous foliar bracts in the spiciform inflorescence .... *13. C. virgata*
ff. Lower, more slender plants; inflorescence not spiciform nor with numerous elongated foliar bracts that greatly exceed the flowers.
g. Inflorescence very broad and rounded in outline; nutlets not wing-margined; native to the eastern slope of the continental divide from Wyoming to central New Mexico .... *20. C. thyrsiflora*
gg. Inflorescence narrower; nutlets usually with an evident wing-margin (except in *C. rugulosa*); native west of the continental divide.
h. Nutlets with evident transverse rugae, these more conspicuous than the tubercles that may be present.
i. Nutlets scarcely or not at all muricate between the rugae.
j. Strictly erect, conspicuously setose perennial of Colorado .... *9. C. stricta*
jj. Caespitose, less conspicuously setose perennials of high elevation in Idaho, Nevada, Oregon, and California. .... *10. C. nubigena*
ii. Nutlets distinctly muricate between the rugae and near the margins of the nutlets.
j. Erect perennials from western Utah .... *24. C. rugulosa*
jj. Caespitose and more or less soboliferous perennials from Montana .... *30. C. sobolifera*
hh. Nutlets with distant tubercles and no conspicuous rugae; native of the southern Sierra Nevada .... *11. C. Clemensae*
dd. Inner surfaces of the nutlets conspicuously and definitely rugose, tuberculate or muricate.
e. Scar of the nutlets evidently open some distance above the base.
f. Scar somewhat constricted some distance below the middle of the open portion.

g. Elevated margin of the scar definitely limited; pustules present on both leaf-surfaces....................*45. C. mensana*

gg. Elevated margin indefinitely limited; pustules present only on the lower surface of the leaves............*42. C. Osterhoutii*

ff. Scar triangular and not constricted below the middle.

g. Some tendency to elevated margin evident around the scar.

h. Cymules elongating and so the inflorescence broad; biennial or short-lived perennials; nutlets with an evident dorsal ridge.

i. Surfaces of the leaves conspicuously setose with spreading bristles; inflorescence crowded..........*15. C. virginensis*

ii. Surfaces of the leaves with inconspicuous appressed bristles; inflorescence open...................*14. C. insolita*

hh. Cymules shorter and inflorescence narrow; long-lived perennials; nutlets with only a slight dorsal ridge, if any.

i. Nutlets indefinitely tuberculate and rugose; California ....*16. C. tumulosa*

ii. Nutlets definitely tuberculate or rugose; Utah and eastern Nevada...........................*17. C. modesta*

gg. No tendency to an elevated margin around the scar.

h. Style exceeding the mature nutlets by 1 mm. or more.

i. Leaves finely strigose and appressed-setulose; densely caespitose perennials of eastern Oregon and adjacent Idaho....................................*34. C. propria*

ii. Leaves setose and tomentose, less densely caespitose. ....*18. C. humilis*

hh. Style not exceeding the mature nutlets by more than 0.5 mm.; densely caespitose perennials of southern Wyoming. ....*19. C. caespitosa*

ee. Scar of the nutlets closed or nearly so, no conspicuous triangular, open area near the base.

f. Upper surface of the leaves uniformly appressed-strigose and without pustules.

g. Nutlets sharply rugose and tuberculate; scar surrounded by an elevated margin............................*44. C. Bakeri*

gg. Nutlets not so sharply rugose or tuberculate; scar not surrounded by an elevated margin.

h. Densely caespitose from a multicipital caudex; native to eastern Oregon and western Idaho.............*34. C. propria*

hh. Less evidently or not at all caespitose; native to Utah, Colorado, and Wyoming.....................*22. C. sericea*

ff. Upper surface of the leaves with two distinct kinds of hairs, pustulate.

g. Densely caespitose perennials; style not over 0.5 mm. longer than mature nutlets; stems not over 1.5 dm. high. ....*19. C. caespitosa*

gg. Caespitose or solitary plants; stems usually more than 1.5 dm. high.

h. Perennials; mostly native in the Rocky Mountains or west of them.

i. Mature sepals exceeding the nutlets by 2–3 mm.; inflorescence broad-topped; western Colorado......*21. C. elata*
ii. Mature sepals exceeding the nutlets by 4–8 mm.
j. Nutlets tuberculate, scarcely if at all rugose.
k. Ventral surfaces of the nutlets nearly smooth; Montana..........................*30. C. sobolifera*
kk. Ventral surfaces of the nutlets distinctly roughened.
l. Stems 1–2 dm. high; inflorescence spreading; western Colorado.....................*23. C. aperta*
ll. Stems 2–9 dm. high; inflorescence usually narrower; Nevada to Montana.
m. Nutlets broadly lanceolate; murications lacking or indefinite; Oregon, Washington, and Montana..................*28. C. Sheldonii*
mm. Nutlets narrowly lanceolate; murications very definite...................*25. C. interrupta*
jj. Nutlets more or less rugose.
k. Scar of the nutlets somewhat open at the base; Nevada and California.................*18. C. humilis*
kk. Scar closed or very nearly so; northerly in range.
l. Nutlets 4–5 mm. long; along the Columbia River and tributary streams in Oregon and Washington..............................*27. C. celosioides*
ll. Nutlets less than 4 mm. long.
m. Leaves narrowly oblanceolate, strongly hirsute-ciliate.
n. Stems slender; nutlets 3–4 mm. long; Idaho and Washington..............*26. C. spiculifera*
nn. Stems slender; nutlets 2–3 mm. long; Canada, Washington, Wyoming..*29. C. Macounii*
mm. Leaves broadly oblanceolate or spatulate.
n. Ventral surfaces of the nutlets nearly smooth; Montana..............*30. C. sobolifera*
nn. Ventral surfaces of the nutlets distinctly rough; Oregon to Montana......*28. C. Sheldonii*
hh. Biennials; native to the plains east of the Rocky Mountains and to the foothill region east of the continental divide................................*31. C. Bradburiana*

Series 1. Jamesianae. Nutlets smooth on all surfaces, or rugose or tuberculate but not at all muricate on the dorsal surface, ventral surfaces quite or nearly smooth. Nutlets often wing-margined. Scar narrow, straight and closed or nearly so. Margins not elevated. Species 1–11.

1. C. Jamesii (Torr.) new comb.

Myosotis suffruticosa Torr. Ann. Lyc. N. Y. 2: 225. 1827, not *Cryptantha suffruticosa* Piper, Proc. Biol. Soc. Wash. 32: 42. 1919.

Perennial; leaves linear-oblanceolate, obtuse or acute, 3–15 cm. long, indument usually appressed, scarcely hispid (in some forms conspicuously setose), pustules small, sometimes confined to the dorsal surface, always more numerous dorsally than ventrally; inflorescence usually open, cymes elongating, setose-hirsute and subtomentose; sepals lanceolate, acute, in anthesis 3–4 mm. long, in fruit 5–6.5 mm. long, exceeding the nutlets by 3–4 mm.; corolla white, tube 2.5–3 mm. long, usually distinctly shorter than the sepals, crests at the base of the tube conspicuous and well developed, fornices probably yellow, elongated, usually emarginate, about 1 mm. long, slightly papillose, limb 6–8 mm. broad, tube and limb subequal, lobes united for $^1/_5$ to $^1/_4$ their length; fruit strongly oblate-ovoid, 1–4 nutlets maturing, style exceeding the nutlets by 1–2 mm.; nutlets rather narrowly ovate-lanceolate in dorsal outline, 2–2.5 mm. long, acute, with margins widely separated, acute, surfaces of nutlets smooth, glossy (with 30 diameters magnification the surfaces are evidently puberulent), scar tightly closed, extending from the base to near the apex, no elevated margin.

Distribution: Upper Sonoran and Transition Zones of the southern Rocky Mountain region from central Wyoming to Chihuahua and from western South Dakota and Texas to Nevada and southern California.

The varieties of *C. Jamesii* are contrasted as follows:

Stems branched from the base, simple above, erect, 2–4.5 dm. tall; leaves tufted at the base; from southern Colorado and Utah to northern Mexico. .... *1a.* var. *multicaulis*

Stems branched from near the base and upwards, erect, 2.5–4 dm. tall; leaves apparently not tufted at the base, linear or nearly so; cymes usually much elongated; northern Mexico and western Texas........ *1b.* var. *laxa*

Stems branched from the base, simple or sparingly branched above, erect, 1.2–2.5 dm. high; leaves somewhat tufted at the base; southern Colorado and Utah to northern New Mexico and Arizona........ *1c.* var. *cinerea*

Stems rather sparingly branched from the base and upwards, erect, 2.5–3.5 dm. high; leaves green, sparsely strigose on both surfaces, conspicuously pustulate below, sparsely so above; southeastern Utah and northeastern Arizona........ *1d.* var. *disticha*

Stems branched upwards as well as from the base, more or less decumbent, 1–3 dm. long; leaves usually not tufted at the base; western Dakota and eastern Wyoming to eastern Colorado........ *1e.* var. *typica*

Stems branched from the base, usually simple upwards, prostrate or nearly so, 0.6–1.5 dm. long; leaves somewhat tufted at the base; eastern deserts of southern California and adjacent Nevada........ *1f.* var. *abortiva*

1a. Var. **multicaulis** (Torr.) new comb. Plate 25, figs. 1–4.

Eritrichium multicaule Torr. in Marcy, Expl. Red River, 262. 1854.

Oreocarya multicaulis (Torr.) Greene, Pittonia 3: 114. 1896.

Krynitzkia multicaulis var. *setosa* Jones, Contr. West. Bot. 13: 4. 1910. (Type: "near Ft. Cove, Utah, June 27, 1901, growing under junipers." *M. E. Jones.*)

Oreocarya suffruticosa var. *multicaulis* (Torr.) Payson, Univ. Wyo. Publ. Bot. 1: 171. 1926.

Perennial from a woody root; stems branched from the base, simple above, erect, rather slender, 20–45 cm. tall, strigose and pilose-hirsute; leaves tufted at the base, 5–15 cm. long, dorsal surface strigose, appressed-setulose (in occasional forms setose-hirsute), pustulate, ventral surface uniformly strigose, rarely sparsely pustulate, petioles long-hairy toward the base, finely ciliate; inflorescence becoming open by the elongation of the cymes, usually confined to the upper ¼, or less, of the stem, foliar bracts inconspicuous; 2–4 nutlets commonly maturing.

Distribution: Upper and Lower Sonoran Zones, northwestern Oklahoma, western Texas, southwestern Colorado, New Mexico, southern Utah, eastern Nevada, Arizona and northern Mexico. Type: from near Santa Fe, New Mexico, *Fendler 636.*

Specimens examined:

Oklahoma: near Knowles, Beaver Co., May 5, 1913, *Stevens 335* (Mo., Gray); near Shattuck, Ellis Co., May 10, 1914, *Clifton 3039* (Mo.); near Shattuck, May 16 and 17, 1914, *Stevens 3039, 3024* (Gray).

Texas: sandhills on Canadian, Hemphill Co., June 4, 1901, *Eggert* (Mo.); Big Springs, May 15, 1902, *Tracy 7835* (Minn., U. S.); Dalhart, June 24, 1920, *Jones 339* (Gray); Ft. Davis, June, 1881, *Havard* (U. S.); Clarendon, 1888, *Nealley* (U.S.).

Colorado: Durango, July 10, 1896, *Tweedy 576* (U.S.); Arboles. June, 1899, *Baker 563* (Pomona, R. Mt., Mo., U.S., Gray).

New Mexico: Tunitcha Mts., Aug. 8, 1911, *Standley 7830* (U.S.); near Cedar Hill, San Juan Co., Aug. 16, 1911, *Standley 7967* (U.S.); near Farmington, San Juan Co., July 20, 1911, *Standley 7125* (U.S.); near Santa Fe, 1847, *Fendler 636* (N.Y., U.S., Gray); near Las Vegas, June, 1920, *Anect 164* (U.S.);

Albuquerque, Sept. 21, 1884, *Jones 6687* (Pomona); near Pecos, San Miguel Co., Aug. 15, 1908, *Standley 4899* (U.S., Mo.); Florita Mts., Sept. 7, 1903, *Jones* (Pomona); Las Palomas, Sandia Mts., April–May, 1914, *Ellis 366* (Mo., U.S.); Balsam Park, Sandia Mts., Aug. 4, 1914, *Ellis 463* (U.S.); Datil, Socorro Co., Sept. 29–Oct. 1, 1919, *Eggleston 16184* (Field); near Roswell, June, 1914, *Wooton* (U.S.); Doña Ana, April, 1851, *Thurber 293* (Gray); Jornada del Muerto, April, 1851, *Thurber 278* (Gray); Organ Mts., Aug. 28, 1897, *Wooton 401* (Pomona, R. Mt., Calif., Minn., Mo., U.S.); Organ Mts., July 15, 1897, *Wooton 595* (Minn., Mo., U.S.); Animas Valley, Oct. 2, 1893, *Mearns 2522* (U.S.); Carrizallito Mts., April 17, 1892, *Mearns 111* (U.S.); Silver City, April 28, 1919, *Eastwood 8366* (U.S., Gray); Middle Fork of the Gila, Mogollon Mts., Aug. 5, 1900, *Wooton* (U.S.); north of Carrizozo, Aug. 28, 1904, *Wooton 2818* (U.S.); Mangas Springs, n.w. of Silver City, May 17, 1903, *Metcalfe 70* (Pomona, R. Mt., Calif., Minn., U.S., Gray); Mogollon Mts., Aug. 9, 1903, *Metcalfe 431* (Pomona, Minn., U.S., Calif., Gray); Gila Hot Springs, Mogollon Mts., Aug. 27, 1903, *Metcalfe 863* (R. Mt., Mo.); Mimbres River, Grant Co., July 1, 1904, *Metcalfe 1061* (U.S.); Santa Rita del Cobre, 1877, *Greene 32* (Gray).

Utah: Pahria Canyon, May 26, 1894, *Jones 5297q, 5298b* (U.S.); canyon above Tropic May, 28, 1894, *Jones 5300* (Pomona, U.S.).

Arizona: Fort Valley, Coconino Nat'l. Forest, July 14, 1909, *Pearson 210* (U.S.); Metcalfe, Oct. 1, 1900, *Davidson 608* (Gray); Ft. Apache, June 21–30, 1890, *Palmer 591* (U.S., in part); Skull Valley, April 28, 1903, *Jones* (Pomona); Flagstaff, Aug. 6, 1884, *Jones 4007* (Pomona, R. Mt., U.S.); Flagstaff, June 4, 1898, *MacDougal 49* (R.Mt., Calif., U.S., Gray); near Flagstaff, June 17, 1901, *Leiberg 5545* (U.S.); Flagstaff, Aug. 25, 1883, *Rusby 749* (Calif., U.S.); northeast of Flagstaff, June 8, 1922, *Hanson A140* (Mo.); San Francisco Mts., Aug. 3, 1923, *Jaeger* (Pomona); San Francisco Mts., April, 1881, *Rusby 283* (Minn., U.S.); San Francisco Mts., Oct. 1881, *Lemmon & wife* (R. Mt.); Williams, Aug. 6–15, 1903, *Griffiths 4912* (U.S.); Bowie, Sept. 18, 1884, *Jones 6685* (Pomona); Cosnino, Aug. 9, 1884, *Jones 4047* (Pomona, U.S.); Santa Rita Forest Reserve, March 31–April 23,

1903, *Griffiths 4268* (U.S.); Alpine, July 31, 1912, *Goodding 1264* (R. Mt., Calif., U.S.); Outlaw Canyon, Chiricahua Mts., July 30, 1907, *Goodding 2349* (R.Mt., Gray).

Nevada: Ely, June 26, 1907, *Jones* (Pomona).

Chihuahua: Mexican boundary near White Water, June 18, 1892, *Mearns 359, 360* (U.S.); base of San Luis Mts., Sept. 5, 1893, *Mearns 2091* (U.S.); Casas Grandes, May 13, 1899, *Goldman 407* (U.S., Gray); plains of Guerrero, Sept. 8, 1887, *Pringle* (Calif.).

1b. Var. **laxa** (Macbr.) new comb.

Oreocarya multicaulis var. *laxa* Macbr. Contr. Gray Herb. **48:** 35. 1916.

Perennial; stems branched from near the base and upwards, erect, rather stout, 2.5–4 dm. high, strigose and hirsute with ascending hairs; leaves numerous, linear or linear-oblanceolate, acute, 6–12 cm. long, rather coarsely and sparsely appressed-strigose below, finely strigose above, pustulate on both surfaces but much more abundantly so on lower; inflorescence broad and open, the cymes becoming much elongated in age (10 cm.), confined to the upper ¼–½ of the stem, foliar bracts not conspicuous, linear.

Distribution: Lower Sonoran Zone in northern Chihuahua, Mexico, and western Texas. Type: sand hills near Paso del Norte, Chihuahua, *C. G. Pringle 776*.

Specimens examined:

Texas: Marfa, Sept. 1883, *Havard* (U.S.).

Chihuahua: sand hills near Paso del Norte, Sept. 20, 1886, *Pringle 776* (Field, Mo., Phila., U.S., Gray, TYPE); between Casas Grandes and Sabinal, Sept. 4–5, 1889, *Nelson 6350* (U.S., Gray).

1c. Var. **cinerea** (Greene) new comb.

Oreocarya cinerea Greene, Pittonia **3:** 113. 1896.

O. Lemmoni Eastw. Bull. Torr. Bot. Club **30:** 239. 1903. (Type: Arizona, without definite locality, 1884, *Lemmon*.)

O. multicaulis var. *cinerea* (Greene) Macbr. Proc. Am. Acad. **51:** 54. 1916.

O. suffruticosa var. *cinerea* (Greene) Payson, Univ. Wyo. Publ. Bot. **1:** 171. 1926.

Perennial; stems branched from the base, simple or sparingly branched above, erect, rather slender, 12–25 cm. high, strigose and setose-hirsute; leaves somewhat tufted at the base, 5–15 cm. long, dorsal surface strigose and appressed-setulose (rarely setose-hirsute), pustulate, ventral surface densely and uniformly strigose, with few or no pustules, petioles long-hairy at the base, finely ciliate; inflorescence becoming open by the elongation of the cymes, usually confined to the upper ⅓ or ⅔ of the stem, bracts of the lower part of the inflorescence rather large and leaf-like; 2–4 nutlets commonly maturing.

Distribution: Upper Sonoran and Transition Zones of south central Colorado, northern New Mexico, southern Utah, northern Arizona and eastern Nevada. Type: "Confined, as far as I know, to the Arkansas Valley, in southern Colorado, where it occupies low subsaline clayey soils," *Greene*.

Specimens examined:

Colorado: Canyon City, June 28, 1917, *Payson 1019* (R.Mt.); Canyon City, June 27, 1895, *Osterhout 628* (R.Mt., Minn., Osterh.); Rocky Ford, June 18, 1900, *Osterhout 2087* (R.Mt., Osterh.); Florence, June 14, 1892, *Cowen* (Mo.); Wet Mountain Valley, June 20, 1873, *Brandegee* (Mo.); plains, Pueblo, 1873, *Greene* (Gray); Pueblo, June, 1890, *Mr. & Mrs. G. H. Hicks 178* (Minn.); mesas near Pueblo, May 14, 1900, *Rydberg & Vreeland 5702* (R.Mt.); Buena Vista, July 6, 1892, *Sheldon 527* (U.S.); Gunnison, July 29, 1925, *Smith 7680* (R.Mt.); Gunnison, July 17, 1901, *Baker 455* (Pomona, R.Mt., Minn., Mo., U.S., Gray).

New Mexico: 15 miles w. of Sante Fe, May 22, 1897, *A. A. & E. G. Heller 3577* (Pomona, Minn., Mo., U.S., Gray).

Utah: along Bullion Creek, above Marysvale, July 21, 1905, *Rydberg & Carlton 7041* (R.Mt., U.S.); Marysvale, May 31, 1894, *Jones 5328* (Pomona, Calif., Mo., U.S.); near Fort Cove, June 27, 1901, *Jones* (Pomona).

Arizona: Moki Indian Reservation, Aug. 1–Sept. 5, 1897, *Hough 8* (U.S.); Grand Canyon, June, 1915, *Macbride & Payson 950* (R.Mt., U.S., Gray); vicinity of Flagstaff, July 2, 1898, *MacDougal 204* (R.Mt., Calif., Phila., U.S., Gray); Cosnino, Aug. 9, 1884, *Jones 4042* (Pomona, R.Mt., U.S.); near Flagstaff, May–Oct., 1901, *Purpus 8195* (Calif., Mo.); Cosnino, June 9, 1890,

Jones (Pomona); San Francisco Mts., June 9, 1893, *Jones 6688* (Pomona); San Francisco Mts., May–Oct., 1900, *Purpus 8048a, 7067* (Calif.); Ash Fork, June 18, 1901, *Barber 112* (U.S.); Prescott, 1876, *Palmer 375* (Gray); Peach Springs, May 26, 1884, *Jones 6684* (Pomona, R.Mt., Calif.).

Nevada: Ely, Aug. 11, 1913, *Hitchcock 1193* (U.S.); Mt. Magruder, May–Oct., 1898, *Purpus 6068* (Pomona, U. S.).

1d. Var. **disticha** (Eastw.) new comb.

Oreocarya disticha Eastw. Bull. Torr. Bot. Club **30**: 238. 1903.

Perennial; stems branched from the base and more or less branched upwards, strigose and sparingly setose with slender ascending trichomes, 2.5–3.5 dm. high, erect; leaves narrowly oblanceolate, obtuse or acute, 5–8 cm. long, green, sparsely strigose on both surfaces, densely pustulate beneath, sparingly so above; inflorescence open, cymes elongating, lax, foliar bracts rather conspicuous; 1–4 nutlets maturing.

Distribution: Upper Sonoran and Transition Zones in southeastern Utah and northeastern Arizona. Type: "on the mesa above the San Juan River, Utah, on what was known as Barton's Range, July 13, 1895," *Eastwood.*

Specimens examined:

Utah: Rabbit Valley, Aug. 12, 1875, *Ward 557* (U.S., Mo.); Thousand Lake Mt., July 14, 1875, *Ward 393* (U.S.); Barton Range, s.e. Utah, July 13, 1895, *Eastwood* (Calif., U.S., Mo., Gray).

Arizona: Lagunå Canyon, July 10–11, 1920, *Clute 37* (U.S., R.Mt., Gray).

1e. Var. **typica** n. var.

Myosotis suffruticosa Torr. Ann. Lyc. N. Y. **2**: 225. 1827.

Eritrichium Jamesii Torr. in Marcy, Expl. Red River, 262. 1854.

Krynitzkia Jamesii (Torr.) Gray, Proc. Am. Acad. **20**: 278. 1885, in part.

Oreocarya suffruticosa (Torr.) Greene, Pittonia **1**: 57. 1887.

Perennial, but probably shorter-lived than in the varieties *cinerea* and *multicaulis;* stems branched upwards as well as from

the base, more or less decumbent, 10–30 cm. long, rather slender, strigose and setose-hirsute; leaves usually not tufted at the base, linear-oblanceolate, 3–8 cm. long, dorsal surface densely strigose and appressed-setulose, pustulate, ventral surface uniformly strigose, only rarely appressed-setulose or pustulate, petioles somewhat ciliate near the base; inflorescence open, mostly confined to the upper ⅓–⅔ of the stem, cymes elongating, bracts of the lower part of the inflorescence elongated and leaf-like; 2–4 nutlets commonly maturing.

Distribution: Upper Sonoran Zone in the western part of South Dakota, Nebraska, and Kansas, northwestern Oklahoma and Texas, southeastern Wyoming, and eastern Colorado. Type: "barren desert along the Platte," *James.*

Specimens examined:

South Dakota: Indian Creek, Aug. 26, 1891, *Williams* (Wash.).

Nebraska: Alliance, June 29, 1913, *Bates 5768* (Minn.); Alliance, May 16, 1914, *Bates 5897* (Minn.); near Plummer Ford, Thomas Co., July 8, 1893, *Rydberg 1514* (N.Y., U.S., Gray); Wild Cat Mts., Banner Co., July 16, 1891, *Rydberg 254* (U.S.); Sidney, May 23, 1922, *Nelson* (R.Mt.).

Kansas: near Hay Springs, June 6–7, 1901, *MacDougal 79* (N. Y., Mont.); Hamilton Co., Aug. 3, 1895, *Hitchcock 347* (R. Mt., U.S., Gray); Syracuse, Hamilton Co., July 11, 1893, *Thompson 97* (N.Y., U.S.); Comanche Co., June 17, 1891, *Carlton 246* (U.S.); Arkalon, Seward Co., June 27, 1888, *Kellerman 6* (U.S.).

Texas: Canadian, July 8, 1912, *Condit* (Calif.).

Wyoming: Casper, July 6, 1901, *Goodding 208* (R.Mt., Pomona, Mo., U.S., Gray); Platte River at Ferris, July 19, 1898, *E. Nelson 4906* (R.Mt., Mo., U.S., Gray); Douglas, July 20, 1915, *Hess 106* (R.Mt.); Uva, July 31, 1896, *Nelson 2567* (R.Mt., Minn.); Platte River Canyon (Wheatland), July 14, 1894, *Nelson 477* (R.Mt., Wash., Minn., Mo., U.S., Gray); Powder River, June 28, 1910, *Nelson 9379* (R.Mt., Minn., Gray); Ft. Laramie, June 29, 1901, *Nelson 8305* (R.Mt.); Pine Bluffs, June 28, 1889, *Bodin* (Minn.); Pine Bluffs, May 15, 1897, *Nelson 2882* (R.Mt.).

Colorado: Wray, July 14, 1909, *Osterhout 3992* (R.Mt., Osterh.); Wray, July 1–4, 1919, *Eggleston 15168* (Pomona); Sterling, Logan Co., June 12, 1896, *Osterhout* (Minn.); Ft. Lupton, July 8, 1916,

Johnston 845 (Mo., U.S.); White Rocks, Boulder Co., July 19, 1918, *Cockerell* (U.S.); near Boulder, July, 1902, *Tweedy 5219* (R.Mt.); barren deserts high up on the Platte, *James* (N.Y., TYPE); Denver, July 10, 1919, *Payson & Bethel 1608* (R.Mt.); North Denver, Aug. 12, 1910, *Eastwood* (Gray); Golden, June 3, 1870, *Greene 300* (Gray); Castle Rock, June 30, 1917, *Payson 1027* (R.Mt.); Table Rock, El Paso Co., July 15, 1891, *Crandall* (Calif.); Colorado Springs, June 26, 1903, *Shantz 571* (U.S.); Colorado Springs, July 3, 1895, *Osterhout 627* (R.Mt., Osterh.); Colorado Springs, July 22, 1920, *Johnston 2809* (Gray); Colorado Springs, June 19–30, 1915, *Eggleston 11194a* (U.S.); Colorado Springs, May 28, 1879, *Jones* (Pomona); Colorado Springs, May 15, 1878, *Jones 66* (U.S.); Salida, Aug. 2, 1925, *Smith 3912* (R. Mt.); Blanca, Costilla Co., June 27, 1921, *Bethel, Nielley & Clokey 4258* (R.Mt., Phila.).

1f. Var. **abortiva** (Greene) new comb.

Oreocarya abortiva Greene, Pittonia **3:** 114. 1896.

Krynitzkia multicaulis var. *abortiva* (Greene) Jones, Contr. West. Bot. **13:** 5. 1910.

Oreocarya suffruticosa var. *abortiva* (Greene) Macbr. Proc. Am. Acad. **51:** 547. 1916.

Perennial from a woody root; stems branched from the base, usually simple upwards, rather slender, prostrate or nearly so, 6–15 cm. long, strigose and hirsute; leaves somewhat tufted at the base, 5–10 cm. long, dorsal surface densely strigose, appressed-setose and pustulate, petioles long-hairy at the base, finely ciliate; inflorescence not raised above the leaves, extending over ¾ of the stem, bracts conspicuous and elongated; 2–3 nutlets frequently aborted.

Distribution: Upper Sonoran Zone in the eastern deserts of southern California and in southern Nevada. Type: "Bear Valley, San Bernardino Mountains, California," *S. B. Parish.*

Specimens examined:

Nevada: Lee Canyon, Charleston Mts., Clark Co., July 28, 1913, *Heller 11016* (Calif., Phila., Field, U.S., Gray).

California: north side of Bear Valley, June 12, 1922, *Munz 5721* (Pomona, Calif., Gray); east of Big Meadows, San Bernardino

Mts., June 21, 1922, *Pierson 3103* (Pomona); Bear Valley, San Bernardino Co., July 19, 1900, *Jones 5315f* (Pomona); Bear Valley, June 16–20, 1895, *Parish 3694* (Calif., Gray); Bear Valley, May, 1882, *Parish 1480* (Calif., Mo., U.S., Gray); Bear Valley, 6500 ft., June 15, 1894, *Parish 3238* (U.S.).

C. Jamesii, in the aggregate sense, is the most widely distributed and most heterogeneous species in the genus. As a species it is very easily recognized by the smooth nutlets that are not in contact by their edges. It is likely to be confused with only two other units that are here accorded specific rank, *C. pustulosa* and *C. Palmeri*. The glabrous stems and ventral leaf surfaces distinguish the former, and the accrescent calyces, longer corolla tubes, and lack of crests at the bases of the tubes identify the latter.

The varieties of *C. Jamesii* are quite difficult of determination, and intermediates between the various groups are of fairly common occurrence. These intermediates are usually in intermediate ranges but occasionally occur far inside the range of a different variety. It is possible, of course, that some of these anomalies are produced by unusual habitats. This is the more probable since the differences between the varieties are entirely those of habit. Since the different forms are fairly well segregated geographically it is to be expected that local floras will continue to treat the variants as separate species. This is greatly to be deplored, since it will overemphasize the distinctions and serve to make determinations difficult.

On the other hand, the general consistency of the varietal ranges makes it certain that the varieties are really incipient species and so worthy of named recognition in any critical work. The author has no doubt but that some specimens cited are incorrectly placed. Sometimes in examining two duplicates of the same collection one is tempted to place one in one variety and the other in a different one. Botanists working in an intermediate range, such as at Flagstaff, Arizona, will probably find the varieties, as in this case, *cinerea* and *multicaulis*, in hopeless confusion.

The setose-hispid form of the variety *multicaulis* is, according to Macbride, to be considered as typical *multicaulis*. He would make the matter of spreading or appressed pubescence the cri-

terion of distinction between *cinerea* and *multicaulis*. It seems to the present author that such a classification cuts across the lines of real relationship. *Cinerea* is more than a form of *multicaulis* with appressed setae. There are more specimens of *multicaulis* with appressed than with spreading setae. *Cinerea* is a growth form intermediate between *multicaulis* and *typica* and as such is perhaps the least definite of the varieties. It might be better to submerge the variety *cinerea* in *multicaulis*. It is on the southern edge of the range of *cinerea* that it is most difficult of delimitation. The var. *setosa* Jones is an exact synonym of Macbride's idea of *multicaulis*.

The variety *laxa* seems certainly more than the ecological variety that Macbride suggested. Other collections of it have confirmed its peculiarities.

The variety *disticha* needs much more study, but the similar collections from the type region seem to assure the general prevalence of an unusually green form of the species in southern and southeastern Utah and adjacent Arizona. The character of the single nutlet maturing is certainly of no value. On part of the type preserved in the herbarium of the University of California some fruits were found with three nutlets. In another collection of similar general appearance four mature nutlets were found.

Other varieties may need to be characterized from time to time. A study of the different varieties in intermediate ranges should prove of great interest to local botanists.

2. **C. pustulosa** (Rydb.) new comb.

Oreocarya pustulosa Rydb. Bull. Torr. Bot. Club **40**: 480. 1913.

Perennial; stems slender, branched at the base, 3–5 dm. high, glabrous or nearly so throughout; leaves linear-oblanceolate, apparently not clustered at the base, numerous on the stems, 3–10 cm. long, acute or obtuse, glabrous and without pustules above, conspicuously and densely pustulate and short-hairy below; inflorescence confined to the upper ¼ or less of the stem, cymes elongating and probably lax in age, foliar bracts inconspicuous; sepals lanceolate, acute, about 4 mm. long in anthesis, probably not conspicuously elongated in fruit, strigose and rather sparsely setose with short, appressed bristles; corolla white, tube 2.5–3

mm. long, somewhat shorter than the sepals in anthesis, crests at the base of the tube evident but not large, fornices about 1 mm. long, slightly papillose, probably yellow, limb 5–6 mm. broad, tube and limb subequal, lobes united for ¼ their length; mature fruit not seen, presumably very like *C. Jamesii.*

Distribution: Upper Sonoran Zone, southeastern Utah. Type: "Hammond Canyon, Elk Mountains, July 31, 1911, *Rydberg & Garrett 9320.*"

Specimens examined:

Utah: Hammond Canyon, Elk Mts., Aug. 10, 1911, *Rydberg & Garrett 9569* (R.Mt., U.S.).

This species is quite unlike any other species of the genus in general appearance, due chiefly to the absence of any conspicuous setae and the quite glabrous stems and upper surfaces of the leaves. The original description characterizes the leaves as being "glabrous beneath, sparingly hairy above." In the specimen at hand it is certainly the upper leaf-surface that is glabrous. The specimen available of this species has more the appearance of a *Heliotropium* or of a *Plagiobothrys* than a *Cryptantha* but there seems no doubt that it is correctly placed in the latter genus. The variety *disticha* of *Jamesii* is probably something of a connecting link between *Jamesii* var. *multicaulis* and the present species.

3. **C. Palmeri** (Gray) new comb.

Krynitzkia Palmeri Gray, Proc. Am. Acad. **20:** 278. 1885.

Oreocarya Palmeri (Gray) Greene, Pittonia **1:** 57. 1887.

Caespitose, long-lived perennial; stems erect, rather stout, 15–30 cm. tall, densely setose with long, rather slender, divaricate hairs; radical leaves linear to linear-oblanceolate, acute, 4–7 cm. long, 2–7 mm. broad, tomentulose and subappressed-setose, abundantly pustulate on the dorsal surface, pustules smaller and fewer on the ventral surface; cauline leaves similar but smaller; inflorescence conspicuously, but rather softly, setose, mainly limited to the upper ¼ of the stem, cymes elongating, foliar bracts inconspicuous; calyx setose, sepals in anthesis linear-lanceolate, acute, about 5 mm. long, in fruit 7–10 mm. long, exceeding the nutlets by 6–8 mm.; corolla probably white, tube 4–5

mm. long, equalling or shorter than the calyx lobes in anthesis, crests lacking at the base of the tube, fornices elongated, papillose, 0.5–1 mm. long, limb about 8 mm. broad, lobes united for ⅙–½ their length, shorter than the tube; fruit strongly oblate-ovoid, all 4 nutlets maturing, style exceeding the nutlets by 3–4 mm.; nutlets very similar to those of *C. Jamesii*, about 3 mm. long, apex acute, margins not in contact, acute, all surfaces smooth, glossy, scar straight, closed or nearly so, extending from the base to beyond the middle, margin not elevated.

Distribution: Lower Sonoran Zone in western Texas and adjacent Mexico. Type: "Coahuila, Mexico, forty miles south of Saltillo, *Dr. Palmer*, March, 1880, no. *895* of the distribution."

Specimens examined:

Texas: rocky hills near Big Spring, Howard Co., June 11, 1900, *Eggert* (Mo., Gray); sandy hills and plains, Upper Concho, April, *Reverchon 2120* (Minn., Field, N. Y., Mo., U.S., Gray); Toyah, Reeves Co., May 2, 1902, *Tracy & Earle 424* (U.S.); from western Texas to El Paso, May–Oct. 1849, *Wright 489* (U.S., Gray).

Coahuila: 40 miles south of Saltillo, March, 1880, *Palmer 895* (Gray, TYPE).

This species has long remained obscure because of the immaturity of the type. The author had designated the plant collected by Reverchon (no. 2120) as the type of a new species before he had examined the type of *C. Palmeri*. Dr. Gray had described *Palmeri* as having subrugose nutlets and this is not true of the Reverchon plant. With the type of *Palmeri* at hand it is evident that the nutlets are subrugose only because they are immature. The other floral characters of *Palmeri* agree very well with the Texan specimen, and it seems very certain that at last the identity of *Palmeri* has been established.

This species is very close to *Jamesii* var. *multicaulis* and is certainly to be considered as a recent derivative from it. Its distinguishing characters are: (1) the accrescent sepals, (2) the corolla tube with no crests at the base, (3) the longer style.

4. **C. oblata** (Jones) new comb. Plate 25, figs. 5–7.

Krynitzkia oblata Jones, Contr. West. Bot. **13:** 4. 1910.

Oreocarya hispidissima Wooton & Standley, Contr. U. S. Nat. Herb. **19:** 545. 1915, not *O. hispidissima* (Torr.) Rydb.

O. oblata (Jones) Macbr. Proc. Am. Acad. **51:** 548. 1916.

O. Paysonii Macbr. Contr. Gray Herb. **48:** 36. 1916 (Type: limestone hills, Berendo Creek, Sierra Co., New Mexico, May 12, 1905, *Metcalfe 1576*).

Caespitose perennial; stems several to many from the base, rather slender, 1.5–2.5 dm. high, hirsute and becoming more conspicuously setose upwards; leaves tufted at the base, linear-oblanceolate, usually acute, 5–10 cm. long, dorsal surface rather coarsely strigose and appressed setose, pustules rather numerous, ventral surface more finely strigose, weakly and sparsely appressed-setose, sparingly pustulate; petioles more or less ciliate toward the base; inflorescence confined to the upper ½ of the stem, cymes somewhat elongated in age and so the thyrsus not very narrow, densely setose with rather slender bristles, foliar bracts inconspicuous; calyx abundantly setose with rather weak bristles, sepals in anthesis nearly linear, 6–7 mm. long, acute, in fruit 10–12 mm. long, exceeding the nutlets 7–8 mm.; corolla white, tube 8–10 mm. long, exceeding the sepals by 2–3 mm., crests lacking at the base of the tube, fornices probably yellow, rounded, broad and low (0.5–1 mm.), minutely papillose, limb 8–10 mm. broad, lobes united for about ¼ their lengths, scarcely half as long as the tube; fruit oblate-ovoid, all four nutlets usually maturing, style exceeding the mature nutlets by 3–5 mm. (species evidently moderately heterostyled); nutlets 2.5–3 mm. long, ovate or nearly circular in outline, obtuse at the apex, margins acute, not quite in contact, surfaces of nutlets glossy, the dorsal rather sparsely tuberculate and more or less rugose, these elevations low and rounded, ventral surfaces smooth, scar closed, extending from the base to about the middle of the nutlet, no elevated margin present.

Distribution: Lower Sonoran Zone of southern New Mexico and adjacent Texas. Probably occurs also on the Mexican side of the Rio Grande near El Paso. Type: "no. *3759* [*M. E. Jones*], El Paso, Texas, April 23, 1884."

Specimens examined:

Texas: Marfa, March 26, 1919, *Hanson 399* (U. S., Gray); near J. Davis' R. C., West Texas, Sept. 1883, *Havard* (U.S.); Fort Bliss, April 22, 1915, *Carlson* (Gray); El Paso, April, 1881, *Vasey*

(Mo.); near El Paso, March, 1851, *Thurber 147* (Gray); El Paso, April 23, 1884, *Jones 3759* (Pomona, TYPE, R.Mt., U.S.); northern base of Chenate Mts., Sept. 1892, *Nealley 167* (Field, N.Y., U.S.).

New Mexico: 1851–52, *Wright 1566* (Field); mesa west of Organ Mts., May 6, 1906, *Standley* (U.S.); Organ Mts., April 4, 1903, *Wooton* (R.Mt., Pomona); Tortugas Mt., Aug. 29, 1902, *Wooton* (U.S.); Tortugas Mt., April 22, 1894, *Wooton* (U.S.); Organ Mts., March 30, 1905, *Wooton* (U.S.); Lake Valley, southern Sierra Co., 1915, *Beals* (U.S.); Berendo Creek, Sierra Co., May 12, 1905, *Metcalfe 1576* (Pomona, Field, Mo., U.S., Gray).

This species is readily distinguished from all other species by the combination of an exserted corolla tube and nutlets that are smooth on the inner surfaces and distinctly roughened on the outer. In general appearance it is not very unlike *C. Jamesii* var. *multicaulis* or var. *cinerea.* In the original description of *C. oblata,* Mr. Jones also cited a specimen from Peach Springs, Arizona. This proves on examination to be *C. Jamesii* var. *cinerea.*

C. oblata is most closely related to *C. Palmeri* and to *C. Jamesii* var. *multicaulis.* It differs from both in having exserted corolla tubes and somewhat roughened nutlets that are quite distinctly wing-margined.

5. **C. confertiflora** (Greene) new comb. Plate 25, figs. 8–10.

Krynitzkia leucophaea var. *alata* Jones, Proc. Calif. Acad. Sci. II. **5**: 710. 1895. (Type: "No. *5289t,* May 23, 1894, Johnson, Utah, 5,000 ft. alt., on sandstone cliffs," *M. E. Jones*).

Oreocarya confertiflora Greene, Pittonia **3**: 112. 1896.

O. leucophaea var. *confertiflora* (Greene) Parish, Erythea **7**: 95. 1899.

O. lutea Greene, Muhlenbergia **2**: 240. 1906; Brand, Fedde, Rep. Sp. Nov. **19**: 73. 1923. (Type: "no. 8211, collected May 9, on rocky slopes in Silver Canyon in the White Mountains, opposite Laws, Inyo County," California, *A. A. Heller*).

O. alata (Jones) A. Nels. Coulter & Nelson, Man. Cent. Rocky Mts., 417. 1909; Rydb. Fl. Rocky Mts. 725. 1917.

Long-lived perennial from a woody root; stems few to many

from a branching caespitose caudex, slender, simple, 15–50 cm. tall, densely white-hairy at base, appressed-strigose and sparingly setose upwards, bristles mostly appressed; leaves somewhat clustered near the base, linear-oblanceolate, acute, 3–10 cm. long, dorsal surface densely strigose and with rather numerous small appressed bristles with pustulate bases, ventral surface uniformly strigose, in age minutely pustulate, petioles ciliate; inflorescence mainly restricted to the upper ½ of the stem or less, usually distinctly glomerate, cymules short, foliar bracts inconspicuous, bristles yellowish in age, divaricate; calyx setose with rather short, weak bristles, sepals in anthesis linear-lanceolate, acute, 7–10 mm. long, in fruit 10–12 mm. long, exceeding the nutlets by about 6 mm.; corolla yellow, tube 9–13 mm. long, 2–3 mm. longer than the sepals, crests at base of the tube usually evident, confluent into a ring (sometimes obsolete), fornices broad, emarginate, about 1 mm. high, limb about 10 mm. broad, lobes united for about ¼ their length, about ⅓ as long as the tube; fruit broadly ovoid (nearly square in cross-section due to the flat dorsal surfaces of the nutlets), all four nutlets commonly maturing, style exceeding the nutlets 3–6 mm. (species conspicuously heterostyled); nutlets broadly ovate in dorsal view, obtuse or subacute, about 3 mm. long, nearly triangular in cross-section, somewhat papery margins in contact, acute, almost wing-margined, surfaces of nutlets glossy, smooth, scar straight, nearly closed, extending from near the base to above the middle of the nutlet, margin not elevated.

Distribution: Upper Sonoran Zone, western Utah, northern Arizona, southern Nevada, and the eastern desert region of southern California. Type: "at Cushenberry Springs on the north side of the San Bernardino Mountains, southern California," *S. B. Parish*.

Specimens examined:

Utah: Dutch Mt., Tooele Co., June 8, 1900, *Jones* (Pomona); Gold Hill, near Clifton, June 13, 1891, *Jones* (Pomona); Dugway, w. Utah, May 27, 1891, *Jones* (Pomona); Fish Springs, June 4, 1891, *Jones* (Pomona, R. Mt., Calif., Mo., U.S.); Elsinore, Sevier Co., June 13, 1899, *Jones* (Pomona); red sand, Springdale, May 17, 1894, *Jones 5261j* (Pomona, U.S.); Wa Wa, 30 miles west of

Frisco, June 25, 1906, *Jones* (Pomona); Vermilion, June 4, 1901, *Jones* (Pomona); canyon south of Glenwood, May 25, 1875, *Ward 108* (Mo., U.S., Gray); Johnson, May 23, 1894, *Jones 5289t* (Pomona); Johnson, June 20, 1890, *Jones* (Pomona); Silver Reef, May 3, 4, 1894, *Jones 5144* (Pomona, R.Mt., Calif., Mo., U.S.); Diamond Valley, May 16, 1902, *Goodding 814* (Pomona, R.Mt., Mo., U.S., Gray); Beaverdam Mts., May, 1874, *Parry 166* (Mo., Gray).

Arizona: 3 miles below Tanner's Crossing, Little Colorado, May 27, 1901, *Ward* (N. Y., U.S.); Red Canyon trail, Grand Canyon, June 10, 1901, *Ward* (U.S.).

Nevada: The Muddy Range, April 10, 1905, *Goodding 2221* (R.Mt., Minn., Mo., Gray); Mormon Mts., Lincoln Co., July, 1906, *Kennedy & Goodding 110* (Calif.); Meadow Valley Wash, mile 16, April 28, 1904, *Jones* (Pomona); Good Springs, May 1, 1905, *Jones* (Pomona); Good Springs, May, 1915, *K. Brandegee* (Calif.); Goldfield, May 14, 1909, *Heller 9619* (Phila.); Esmeralda Co., *Shockley* (Calif.).

California: Andrew's Camp, Bishop Creek, Inyo Co., July, 1911, *Davidson 2722* (Gray); Andrew's Camp above Bishop Creek, July, 1913, *K. Brandegee* (Pomona, Calif.); Bishop Creek, May 31, 1906, *Hall & Chandler 7234* (Calif.); northern slope of San Bernardino Mts., May, 1882, *Parish 1319* (Calif.); near summit of Wild Rose Canyon, Inyo Co., *Parish 19167* (Calif.); Cactus Flat, desert slope of San Bernardino Mts., June 2, 1901, *Parish 4887* (Calif., U.S.); San Bernardino Mts., June 17, 1894, *Parish 3240* (Mo., U.S.); Water Canyon, San Bernardino Mts., May, 1882, *Parish 1316* (Mo., Gray); near Cushenberry Springs, Mojave Desert, May, 1882, *Parish & Parish 1316* (Calif., Mo.); Erskine Creek, May, 1897 ('98?), *Purpus 5323* (Calif., Mo., U.S., Gray); White Mts., 1898, *Purpus 5802* (Calif., U.S.); Silver Canyon east of Laws, May 9, 1906, *Heller 8211* (Calif., Mo., Phila., U.S., Gray); south of Mono Lake, July 8, 1863, *Brewer 1822* (U.S.); Pleasant Canyon, Panamint Mts., May 6, 1897, *Jones* (Pomona, U.S.); Kern River, *Austin* (Calif.); Olancha Mt., Tulare Co., June 25–30, 1904, *Hall & Babcock 5270* (Calif.).

C. confertiflora and its close relatives, *C. flava* and *C. leucophaea*, are readily distinguishable from all other species of the section

by their long corolla tubes and smooth nutlets. They are not so easily separable from one another, however, and a broader specific concept would unite them as varieties of one species. The three units are definitely segregated geographically, and the morphological differences, when once noted, seem to be constant. The principal characteristics may be summarized as follows: *C. confertiflora* and *C. flava* have yellow flowers, while *C. leucophaea* has white ones. The nutlets in the first and last are definitely ovate in outline while in the second they are much narrower. The inflorescence in *confertiflora* is distinctly glomerate while in the related species it is continuous or nearly so.

Dr. Brand legally published the *nomen nudem Oreocarya lutea* Greene. He did this in the belief that *lutea* Greene was specifically distinct from *confertiflora.* He says "Macbride stellt in seiner im Jahre 1916 erschienen Monographie der Gattung *Oreocarya* den Namen *O. lutea* Greene als Synonym zu *O. confertiflora.* Aber abgesehen von der goldgelben Blütenfarbe sind bei *O. lutea* die Staubblätter an der Spitze des Kronentubus dicht unter den Hohlschuppen eingefügt, wahrend sie bei *O. confertiflora* (*O. flava*) in der mitte der Kronenrohre sitzen und von den Hohlschuppen durch einen deutlichen Zwischenraum getrennt sind." These differences in position of the stamens in the tube are obviously of no taxonomic value in the present case, since the present species is very definitely dimorphic as regards stamen insertion and length of style and both forms are commonly found growing in close proximity.

6. **C. flava** (A. Nels.) new comb. Plate 25, figs. 11–13.

Oreocarya flava A. Nels. Bull. Torr. Bot. Club **25:** 202. 1898.

O. lutescens Greene, Pittonia **4:** 93. 1899. (Type: "common on hills about Aztec, New Mexico, 25 April, 1899," *C. F. Baker.*)

Very similar in habit of growth to *C. confertiflora;* stems 15–35 cm. tall, bristles somewhat coarser and more widely spreading than in *confertiflora;* leaves linear or linear-oblanceolate, acute, 3–9 cm. long, dorsal surface densely appressed-strigose and with numerous small appressed bristles with pustulate bases, ventral surface uniformly strigose in age, with rather numerous pustulate hairs, petioles ciliate; inflorescence usually restricted to the upper

½–¾ of the stem, scarcely glomerate, indument very similar to that in *confertiflora*, possibly more strongly setose; calyx setose with rather strong divaricate bristles, sepals in anthesis linear-lanceolate or quite linear, acute, about 10 mm. long, in fruit scarcely enlarged, exceeding the nutlets by about 6 mm.; corolla yellow, tube 9–11 mm. long, 2–3 mm. longer than the sepals, crests at the base of the tube usually obsolete, rarely vestigial, fornices very similar to those in *confertiflora*, limb 8–9 mm. broad, lobes united for about ¼ their length, less than ½ as long as the tube; fruit lance-ovoid, usually less than 4 nutlets maturing (often only 1 or 2), style exceeding the nutlets 2–7 mm. (species conspicuously heterostyled); nutlets lanceolate in dorsal view, acute, 3–4 mm. long, firmer in texture than in *confertiflora*, margins in contact, acute, not wing-margined, surfaces of nutlets glossy, smooth, dorsal somewhat more rounded crosswise than in *confertiflora*, ventral not so distinctly keeled, scar similar.

Distribution: Upper Sonoran Zone in southern Wyoming, western Colorado, northwestern New Mexico, eastern Utah, and northeastern Arizona. Type: Point of Rocks, Sweetwater Co., Wyoming, June 1, 1897, *A. Nelson 3074*.

Specimens examined:

Wyoming: Alcova, Natrona Co., July 1, 1901, *Goodding 164*, (R.Mt., Pomona, Field, Mo., U.S., Gray); hills of the Platte in the mountains, *Nuttall* (Phila.); Cooper Creek, June 18, 1892, *Nelson 22* (Gray); Medicine Bow, July 9, 1898, *E. Nelson 4397* (R.Mt., Field); T. B. Ranch, Carbon Co., June 20, 1901, *Goodding 53* (R.Mt.); Ft. Steele, May 25–June 10, 1901, *Tweedy 4262* (U.S.); 3 miles north of Saratoga, July 3, 1922, *Payson & Payson 2533* (R.Mt., Pomona, Colo., Mo., Gray); Ft. Steele, June 16, 1907, *Nelson* (R.Mt.); northeast corner of Sweetwater Co., July 6, 1926, *Nelson 10693* (R.Mt.); Bitter Creek, June 16, 1898, *Nelson 4771* (R.Mt.); Bitter Creek, June 2, 1897, *Nelson 3098* (R.Mt.); Point of Rocks, June 1, 1897, *Nelson 3074* (R.Mt., TYPE); Steamboat Mt., Sweetwater Co., June 9, 1900, *Nelson 7067* (R.Mt., Pomona, Minn., Mo., U.S., Gray); 20 miles east of Point of Rocks, July 4, 1922, *Payson & Payson 2557* (R.Mt.); near Leucite Hills, June 17, 1901, *Merrill & Wilcox 497* (R.Mt., U.S., Gray); same locality and date, *486* (U.S.); near Washington's

Ranch, June 30, 1901, *Merrill & Wilcox 726* (R.Mt., U.S., Gray); Rock Springs, July 7, 1925, *Payson & Payson 4307* (R.Mt.); Green River, June 23, 1896, *Jones 6725* (Pomona).

Colorado: 8-10 miles west of Craig, June 17, 1925 *Osterhout 6389* (R.Mt.); Grand Junction, May 17, 1892, *Eastwood* (Calif., Mo., U.S., Gray); Grand Junction, May 28, 1894, *Crandall* (Calif.); Grand Junction, June 20, 1898, *Bethel* (Colo.); Grand Junction, June 19, 1915, *Macbride & Payson 705* (R.Mt., Gray); Dolores River near Mesa Creek, June 11, 1914, *Payson 405* (R. Mt., Gray).

New Mexico: Aztec, April, 1899, *Baker 562* (Pomona, R.Mt., Calif., Mo., Gray); Fort Defiance, 1869, *Palmer* (U.S.).

Utah: Uinta Mts., 1902, *Langille 117* (U.S.); Myton, May 20, 1908, *Jones* (Pomona); Theodore to Myton, May 19, 1908, *Jones* (Pomona); between the K. Ranch and Jensen, June 18, 1925, *Osterhout 6406* (R.Mt.); Price, June 10, 1900, *Stokes* (Calif.); Green River, June 12, 1901, *Stokes* (Minn., U.S.); Green River, May 8, 1909, *Tidestrom 2031* (U.S.); Thompson's Springs, May 3, 1891, *Jones* (Pomona); Thompson's Springs, May 7, 1891, *Jones* (R.Mt.); Moab and vicinity, July 1–2, 1911, *Rydberg & Garrett 8431* (N.Y.); Cisco, May 2, 1890, *Jones* (Pomona, R.Mt., Calif.); San Rafael Swell, May 15, 1914, *Jones* (Pomona); in clay, near Orangeville, June 18, 1894, *Jones 5464* (Pomona, Calif., Mo., U.S.); 2 miles north of Ferron, June 18, 1894, *Jones 5455c* (U.S., Pomona).

Arizona: 5 miles east of Tuba, May 30, 1901, *Ward* (N.Y., U.S.); plants of the Hopis, *Voth 103, 15* (Field); Adamana, Petrified Forest, June 27, 1913, *Hitchcock 7* (U.S.).

The interpretation here given to *flava* is somewhat more inclusive than that in Macbride's revision inasmuch as Macbride referred all plants from western Colorado to *confertiflora* while they are now placed in *flava*. The characters ascribed to the two species by Macbride are those accepted here. The discrepancy in range is probably due to the comparative immaturity and paucity of the specimens cited by Macbride from Colorado. For a discussion of the distinction between *flava* and related species see under *C. confertiflora*.

7. **C. leucophaea** (Dougl.) new comb. Plate 25, figs. 14–16.

Myosotis leucophaea Dougl. in Lehm. Pug. **2**: 22. 1830.

Eritrichium leucophaeum (Dougl.) A.DC. Prodr. **10**: 129. 1846.

Krynitzkia leucophaea (Dougl.) Gray, Proc. Am. Acad. **20**: 280. 1885.

Oreocarya leucophaea (Dougl.) Greene, Pittonia **1**: 58. 1887.

Very similar in habit of growth to *C. confertiflora;* stems 15–40 cm. tall, white-hairy at the base, densely strigose but scarcely setose upwards except in the inflorescence; leaves linear to linear-oblanceolate, acute, 3–9 cm. long, dorsal surface densely strigose and with numerous weak bristles with pustulate bases, ventral surface uniformly strigose, pustules few or none, leaf-bases and petioles ciliate; inflorescence mainly restricted to upper ½ of the stem, scarcely glomerate, indument rather softly setose, bristles divaricate, white, not turning yellowish in age; calyx setose with rather weak bristles, sepals in anthesis linear or nearly so, acute, about 10 mm. long, in fruit 13–14 mm. long, exceeding the nutlets by 7–8 mm.; corolla white, tube 8–11 mm. long, 1–2 mm. longer than the sepals, crests at the base of the tube evident, fornices linear-oblong, emarginate, 1 mm. long, probably yellow, limb 8–10 mm. broad, lobes united about ¼ their length, less than half as long as the tube; fruit ovoid, usually less than 4 nutlets maturing, style exceeding the mature nutlets 1.5–7 mm. (species heterostyled); nutlets ovate, acute, 3–4 mm. long, rather thin, margins in contact, acute, almost wing-margined (less so than in *C. confertiflora*, more than in *C. flava*), surfaces of nutlets glossy, smooth, scar as in *C. confertiflora.*

Distribution: Upper Sonoran Zone in south-central Washington—reported from southern British Columbia (Macoun, Cat. Canad. Pl. **2**: 338. 1884, and Henry, Fl. Southern British Columbia, 254. 1915), and probably to be found in northern Oregon. Type: "arid barrens of the Columbia, and of its northern and southern tributaries." Collected by *Douglas.*

Specimens examined:

Washington: "ex dupl. Hook." *Douglas* (Gray); Columbia River from lat. 46° to 49° N., 1860, *Lyall* (Gray); near Morgan's Ferry, Yakima River, June 8, 1884, *Suksdorf 407* (Gray); near Egbert Spring, Douglas Co., July 4, 1893, *Sandberg & Leiberg 373*

(Wash., Pomona, R.Mt., Calif., Minn., Field, Mo., Phila., U.S., Gray); Pasco, May 26, 1899, *Piper 2987* (Wash.); Pasco, July 11, 1897, *Piper* (R.Mt.); Pasco, May 20, 1899, *Piper 2987* (Gray); Pasco, May 25, 1896, *Hindshaw 2* (Wash.); Pasco, July, 1898, *Elmer 1056* (Wash., Minn., U.S.); Scott, Klickitat Co., May 16, 1898, *Leckenby* (Wash.); 2 miles s.w. of Attalia, May 6, 1911, *Beattie 3921* (Wash.); Burbank, Walla Walla Co., May 29, 1922, *Lechiner 3* (Wash.); Walla Walla region, June, 1883, *Brandegee 997* (Phila., Calif., Gray); Wallula, May 23, 1903, *Cotton 1027* (Wash., U.S., Gray).

For a discussion of the differences between this species and the closely related ones see under *C. confertiflora*. *C. leucophaea* is of especial interest because it is so widely separated geographically from its very near allies.

8. **C. salmonensis** (Nels. & Macbr.) new comb.

Plate 25, figs. 17–19.

Oreocarya salmonensis Nels. & Macbr. Bot. Gaz. **61**: 43. 1916.

Perennial and caespitose; stems rather stout, 1.5–3 dm. high, setose with rather weak, white hairs, as well as strigose-tomentulose; leaves rather narrowly oblanceolate to spatulate, clustered at the base, numerous upwards, acute or obtuse, more or less tomentulose on both surfaces, setose with rather weak hairs, pustulate dorsally and ventrally; inflorescence on upper ½ of the stem, rather narrow or sometimes broader by the elongation of the cymules, foliar bracts not conspicuous; calyx abundantly setose with white, rather slender hairs; sepals in anthesis linear-lanceolate, acute, about 3 mm. long, in fruit 5–7 mm. long, exceeding the nutlets by about 3 mm.; corolla white, tube 3 mm. long, equalling or slightly shorter than the sepals, slightly shorter than the limb, crests at the base of the tube well developed, fornices distinctly papillose, probably yellow, 0.5–1 mm. long, emarginate, limb 8–10 mm. broad, lobes united for about ⅓ their length; fruit lanceolate-ovoid, 3–4 nutlets usually maturing, style 1.5 mm. longer than the mature nutlets; nutlets lanceolate, obtuse, 3–4 mm. long, with margins in contact, rather indefinitely wing-margined, all surfaces smooth, glossy, scar straight, closed, extending the full length of the nutlets, no elevated margin evident.

Distribution: Upper Sonoran areas in central Idaho. Type: *Charles L. Kirtley*, Salmon, Idaho.

Specimens examined:

Idaho: Salmon, June, 1896, *Kirtley* (R.Mt., TYPE); Salmon, July 3, 1920 *Payson & Payson 1880* (R.Mt., Mo., Gray); Challis, July 21, 1916, *Macbride & Payson 3348* (R.Mt., U.S., Mo., Gray).

There can be no doubt as to the right of this plant to specific recognition. It is perhaps most closely related to *C. leucophaea* but is at once separable from that by the short corollas, the more hispid indument, and the broader leaves.

9. **C. stricta** (Osterhout) new comb. Plate 26, figs. 20–22.

Oreocarya stricta Osterh. Bull. Torr. Bot. Club **50**: 217. 1923.

Perennial; stems solitary or 2 or 3 from a tap-root, rather slender, strictly erect, 1.5–3 dm. high, conspicuously setose with strong, divaricate bristles and sparsely retrorse-strigose; leaves clustered at the base of the stem, oblanceolate, usually acute, 2–5 cm. long, conspicuously veined longitudinally, strongly setose with spreading bristles and strigose pustulate hairs about equally numerous on both leaf surfaces, cauline leaves similar to the basal, reduced upwards; inflorescence apparently rather narrow and crowded, extending over the upper 1/4 or 1/3 of the stem, densely setose, foliar bracts quite small and inconspicuous; calyx strigose and setose with spreading bristles, sepals narrowly lanceolate, acute, 4–5 mm. long in anthesis, 6–8 mm. long in fruit, exceeding the nutlets by about 3 mm.; corolla quite yellow in dried material but Mr. Osterhout believes it to have been white with yellow fornices, tube 3.5 mm. long, equalling or shorter than the sepals, crests well developed at the base of the tube, fornices low, rounded, limb 8–10 mm. broad, tube and limb subequal, lobes united for 1/4 to 1/3 their length; fruit lanceolate-ovoid, all four nutlets usually maturing, style exceeding the mature nutlets 1–1.5 mm.; nutlets lanceolate or elliptical, obtuse or subacute, with margins in contact, narrowly winged, acute, surfaces of nutlets glossy, the dorsal definitely rugose and sometimes tuberculate, not muricate, ventral surfaces smooth or nearly so, scar straight, extending from the base to near the apex, nearly closed, no elevated margin present.

Distribution: Upper Sonoran Zone, northwestern Colorado. Type: collected "some distance south of the Yampa or Bear River in Moffat County (Colorado) along the Victory Highway."

Specimens examined:

Colorado: some distance south of the Yampa River along the Victory Highway, June 21, 1922, *Osterhout 6195* (R.Mt., Osterh., TYPE, Gray).

C. stricta is a very distinct species and although only known at present from a single collection, must take its place as one of the major units in any study of the genus. It is difficult to say to what species it is most closely allied. The nutlet characters would place it nearest to *C. nubigena* but it is more than probable that these similarities represent merely a convergent development rather than an actual immediate relationship. *C. stricta* may represent a separate line of evolution from *C. Jamesii* var. *multicaulis* or an offshoot from the *confertiflora-flava* branch.

10. C. nubigena (Greene) new comb. Plate 26, figs. 23–25.

Oreocarya nubigena Greene, Pittonia 3: 112. 1896.

Perennial and caespitose from a woody root; stems several, slender or rather stout, 16–20 cm. high, setose and hirsute, bristles divaricate; leaves oblanceolate to spatulate, obtuse, tapering gradually to a somewhat ciliate petiole, 2–4 cm. long, setose with curved bristles, hirsute and more or less tomentulose, pustulate bases to the bristles present on both surfaces, more abundant and earlier evident on the dorsal surface; inflorescence confined to the upper ½ or less of the stem, narrow, somewhat glomerate or compact, foliar bracts inconspicuous, densely setose; calyx setose with divaricate or somewhat reflexed bristles, hirsute, sepals in anthesis linear-lanceolate, somewhat obtuse at the very tip, 3–4 mm. long, in fruit 7–9 mm. long, exceeding the nutlets by 2–3 mm.; corolla white, tube 3–4 mm. long, equalling the calyx lobes, crests at base of the tube evident, fornices prominent, broad, papillose, yellow, about 0.5 mm. high, limb 4–7 mm. broad, lobes slightly shorter than the tube (measuring from the fornices), united for about ⅓ their length; fruit elongated and narrowly ovoid, all 4 nutlets commonly maturing, style equalling the mature nutlets or exceeding them 0.5–1.5 mm.; nutlets narrowly

lanceolate, acute or obtuse, 4–5 mm. long, somewhat glossy, margins in contact, acute, apices spreading, dorsal surface of nutlets nearly smooth or (usually) indefinitely rugose and tuberculate, somewhat margined, ventral surface smooth or indistinctly wrinkled, scar narrow, straight, extending from near the base nearly to the apex.

Distribution: in the high mountains, south-central Idaho, northwestern Nevada, Oregon and northern and eastern California. Type: "On Cloud's Rest, Mariposa Co., California, 10 July, 1889," *Messrs. Chestnut & Drew.*

Specimens examined:

Idaho: Smoky Mts., Blaine Co., Aug. 13, 1916, *Macbride & Payson 3771* (R.Mt., Mo., U.S., Gray).

Nevada: Santa Rosa Mts., July 11, 1898, *Cusick 2028* (R.Mt., Calif., Minn., Mo., U.S., Gray).

Oregon: Pine Creek, Baker Co., Sept. 1879, *Cusick* (Gray); dry banks above the John Day River, Prairie City, Grant Co., July 1, 1919, *Ferris & Duthie 734* (R.Mt.); Warner Mts., July 1898, *Austin & Bruce 2270* (Pomona); Crater Lake, Sept. 14, 1902, *Coville 1514* (U.S.).

California: Scott's Mt., north Calif., Aug. 30, 1880, *G. Engelmann* (Mo.); Mt. Eddy, Siskiyou Co., July 9, 1920, *Heller 13435* (Field, N. Y., Mo., U.S.); head North Fork, Parker Creek, Warner Mts., Modoc Co., July 13, 1910, *Taylor & Bryant* (Calif.); mountain near Sonora Pass, July 16, 1863, *Brewer 1887* (Calif.); summit of Cloud's Rest, July 13, 1889, *Chestnut & Drew* (Calif.).

It is not felt that the treatment here accorded *nubigena* is particularly satisfactory. The specimens at hand are comparatively few and from widely separated localities. They are not particularly homogeneous among themselves. It is possible that the species may be separable into several geographic varieties when it is better known. Perhaps it is simply an especially polymorphic unit and any one locality will give great extremes of variation. Even its relationship to other species is not clear.

Because of its range and habitat, *nubigena* is most likely to be confused with *humilis.* That it is really closely related to it is not so certain. The outstanding peculiarities of *nubigena* are its greatly elongated nutlets that are nearly smooth on the inner sur-

faces. A satisfactory concept of this species must await further study and exploration.

11. C. Clemensae Payson[1] Plate 26, figs. 26–28.

Perennial, probably short-lived; stems numerous from the rather slender root, the underground portions densely clothed with the leaves of previous years, very slender, 6–12 cm. high, setose; leaves narrowly oblanceolate or spatulate, rather thin, 2–3 cm. long, obtuse or subacute, rather sparsely hairy with spreading, hirsute trichomes and small, pustulate setae, both surfaces pustulate, the upper much less densely so than the lower; inflorescence subcapitate, rarely over 3 cm. long, foliar bracts inconspicuous; calyx densely setose with rather slender bristles, rather sparsely strigose, sepals in anthesis 3–4 mm. long, linear-lanceolate, in fruit about 7 mm. long, exceeding the nutlets by 3–4 mm.; corolla white, tube 2.5 mm. long, shorter than the sepals in anthesis, crests at the base of the tube evident, fornices well developed, probably white, 0.5–1 mm. long, scarcely papillose, limb about 4 mm. broad, tube distinctly longer than the limb, lobes united for about ⅓ their length; fruit elongated and narrowly ovoid, all four nutlets commonly maturing, style exceeding the mature nutlets by 0.5–1 mm., margins in contact or nearly so, acute; nutlets somewhat papery, linear-lanceolate, acute, 3 mm. long, very definitely but narrowly wing-margined, surfaces slightly glossy, the dorsal sparsely tuberculate, the tubercles low and sometimes elongated but apparently not often forming rugae, ventral surfaces nearly smooth except for the veining of the pericarp, scar straight, extending from near the base nearly to the apex, open but narrow, no elevated margin present.

[1] **Cryptantha Clemensae** sp. nov., perennis; caulibus multis gracilibus setosis 6–12 cm. altis; foliis anguste oblanceolatis aut spathulatis tenuibus obtusis aut subacutis hirsutis et setosis supra et subter pustulosis; inflorescentibus subcapitatis; sepalis setosis linearo-lanceolatis 3–4 mm. longis, fructiferis ca. 7 mm. longis, quam nuculae 3–4 mm. longioribus; corolla alba, tubo 2.5 mm. longo, quam sepalis brevioribus, limbo ca. 4 mm. lato; stylo nuculas 0.5–1 mm. superante; nuculis linearo-lanceolatis acutis 3 mm. longis anguste alatis, facie exteriore sparse tuberculosis, faciebus ventralibus fere laevibus, sulco recto angusto, margine non edito.—Collected by *Mrs. Joseph Clemens*, Glenn's Pass, California, July 22, 1910, (R. Mt. Herb., TYPE).

Distribution: in the southern Sierra Nevada of California. Type: Glenn's Pass, California, July 22, 1910, *Mrs. Joseph Clemens.*

Specimens examined:

California: Glenn's Pass, July 22, 1910, *Clemens* (R.Mt., TYPE, Pomona); Mt. Whitney, July 11, 1910, *Clemens* (Pomona); near Mt. Whitney, Sept. 1, 1891, *Bailey, Coville & Funston* (U.S.); Mt. Whitney, alt. 13,000 ft., Aug. 17, 1899, *Copeland 52* (U.S.).

Presumably this species is most closely related to *C. nubigena*, and its geographical location and habitat make it reasonable to suppose that it is a derivative from that plant. From *nubigena*, *C. Clemensae* is very different in general appearance. The thin, green and rather flaccid leaves give it an appearance that is quite unusual in the genus. The small, rather turgid but narrowly winged nutlets are also quite characteristic. It seems as distinct a unit as has been described in the genus; indeed the author's chief hesitation in describing the plant has been because it seemed so aberrant in the section *Oreocarya* that it might be best placed in some other group. A study of the flowers and fruit seems to make it certain that it must be placed in *Cryptantha*, and the perennial root and compact inflorescence definitely place this plant in the section *Oreocarya*.

The species is named in honor of the indefatigable collector, Mrs. Joseph Clemens.

Series 2. VIRGATAE. Stout, erect biennials or perennials with unbranched stems. Nutlets smooth, or nearly so, on the ventral surfaces, variously roughened on the dorsal — or in some forms of *C. virgata* — quite smooth. Species 12–13.

12. C. setosissima (Gray) new comb. Plate 26, figs. 29–31.

Eritrichium setosissimum Gray, Proc. Am. Acad. **12:** 80. 1877.

Krynitzkia setosissima Gray, Proc. Am. Acad. **20:** 276. 1885.

Oreocarya setosissima (Gray) Greene, Pittonia **1:** 58. 1887.

Short-lived perennial or possibly a biennial from a stout taproot; stem usually solitary, unbranched, stout, 2.5–8 dm. tall, setose and hirsute; leaves clustered at the base, linear-oblanceolate, obtuse, the lower 6–12 cm. long, somewhat reduced up-

wards, setose and hirsute, bristles not so coarse nor so widely spreading as in *C. virgata*, pustulate hairs numerous on both surfaces but more numerous dorsally; inflorescence rarely extending over more than ½ of the stem, foliar bracts scarcely exceeding the branches of the inflorescence, this elongating and spicate rather than glomerate; calyx densely hirsute and setose; sepals in anthesis lanceolate, acute or obtuse, about 6 mm. long, in fruit linear-lanceolate, acute or obtuse, about 10 mm. long, exceeding the nutlets by about 5 mm.; corolla white, tube about 4 mm. long, equalled by the calyx lobes, constricted above the ovary with a thickened ring of crests, fornices distinctly emarginate, 0.5 mm. high, probably yellow, limb about 8 mm. broad, lobes united about 1/6 their length; fruit ovoid, all four nutlets commonly maturing, style exceeding the nutlets by 1.5 mm.; nutlets in contact, ovate, obtuse, 4–5 mm. long, papery rather than bony, surrounded by a conspicuous wing-margin nearly 1 mm. wide, surfaces somewhat glossy, dorsal uniformly and openly muriculate with a few larger tubercles or short rugae, ventral surface smooth or nearly so, scar straight, narrow, open, extending from very near the base to near the apex.

Distribution: Transition Zone from south-central Utah to southern Arizona. Type: "shores of Fish Lake, Utah, at 8,700 feet, *L. F. Ward,*" in Powell's Expedition, 1875.

Specimens examined:

Utah: Bromide Pass, Henry Mts., July 27, 1894, *Jones 5692al* (U.S.); Panguitch Lake, Sept. 7, 1894, *Jones 6015al* (Pomona, U.S.); Fish Lake, Aug. 9, 1894, *Jones 5790m* (Pomona, U.S.); Fish Lake, Aug. 10, 1894, *Jones 5812* (Pomona, R.Mt., Calif., Mo., U.S.); Fish Lake, Aug. 25, 1875, *Ward 646* (Phila., Mo., U.S., Gray, TYPE); St. George, 1877, *Palmer 357* (Mo., Gray).

Arizona: Grand Canyon of the Colorado, June 26, 1898, *MacDougal 165* (R.Mt., Calif., Phila., U.S., Gray); Grand Canyon, July 9, 1892, *Toumey 224* (U.S.); rim of Grand Canyon, July 12, 1892, *Wooton* (U.S.); San Francisco Mts., Sept. 1884, *Lemmon & wife* (Calif.); San Francisco Peaks, July 26, 1901, *Leiberg 5748* (U.S.); Flagstaff, Aug. 7, 1884, *Jones 6686* (Pomona); Flagstaff, May–Oct. 1900, *Purpus 8048* (Pomona, Calif., Mo., U.S.); Flagstaff, Aug. 1883, *Rusby 748* (Calif., Phila., U.S.); Mt. Hum-

phrey, July 26, 1897, *Kunze* (N.Y.); Bill Williams Mt., July 5, 1889, *Greene* (Calif., U.S.); Nagle's Ranch (northwestern Arizona), Sept. 17, 1894, *Jones 6054s* (U.S.); Ft. Apache, June 21–30, 1890, *Palmer 591* (Calif., Gray, U.S., in part); 66 miles south of Holbrook, July 4, 1901, *Hough 88* (U.S.); Thompson's Ranch, Black River, White Mts., July 14, 1910, *Goodding 589* (R.Mt., U.S., Gray); White Mts., Aug. 6–15, 1903, *Griffiths 5300* (U.S.); near Santa Catalina Mts., Aug. 1881, *Lemmon & wife* (R.Mt.).

This is certainly one of the most distinct units in the section *Oreocarya*. It is remarkably uniform in character and is to be confused with no other species. In general appearance it is somewhat similar to *C. virgata*, and for that reason is associated with it in the series. This resemblance may be no indication of real relationship. The nutlets of certain annual species of *Cryptantha*, notably *C. utahensis*, *C. holoptera*, and *C. pterocarya*, are remarkably similar to those of *C. setosissima* and suggest the possibility that some of the annual forms of the genus may have developed from perennial forms in North America. It was doubtless this similarity of nutlets that led Greene (Pittonia **1**: 58. 1887) to transfer one of the annual species to *Oreocarya*. This was *O. holoptera* (Gray) Greene; now treated as *Cryptantha holoptera* (Gray) Macbride.

13. C. virgata (Porter) new comb. Plate 26, figs. 32–34.

Eritrichium virgatum Porter, Hayden Rept. 479. 1870.

E. glomeratum var. *virgatum* Porter in Porter & Coulter, Syn. Fl. Colo. 102. 1874.

Krynitzkia virgata (Porter) Gray, Proc. Am. Acad. **20**: 279. 1885.

Oreocarya virgata (Porter) Greene, Pittonia **1**: 58. 1887.

O. spicata Rydb. Bull. Torr. Bot. Club **36**: 678. 1909. (Type: Artist's Glen, Pikes Peak, Colorado, Aug. 1, 1901, *Clements 102*.)

O. virgata forma *spicata* (Rydb.) Macbr. Proc. Am. Acad. **51**: 546. 1916.

Biennial from a stout taproot; stem usually solitary, unbranched, stout (when the terminal bud is injured a number of rather slender stems may be developed), 2.5–7 dm. tall, densely setose with long, stout, divaricate bristles, hirsute; leaves narrowly

oblanceolate, obtuse, 3–12 cm. long, hirsute and setose, appressed pubescence lacking, pustulate hairs numerous on both surfaces but somewhat more numerous dorsally; inflorescence usually extending along at least ¾ of the stem, uniformly cylindrical in outline, conspicuously bracteate with linear-oblanceolate foliar bracts that much exceed the cymules in length; calyx setose and hirsute, indument not essentially different from that of the leaves, sepals in anthesis lanceolate, acute, 4 mm. long, in fruit linear-lanceolate, acute or slightly obtuse, 11 mm. long, exceeding the nutlets by about 6 mm.; corolla white, tube about 3.5 mm. long, slightly exceeded by the calyx lobes, with a conspicuous thickened ring of crests just above the ovary, fornices papillose, yellow, distinctly emarginate, 0.5 mm. high, limb 8–10 mm. broad, lobes united about ⅓ their length; fruit broadly ovoid, all four nutlets commonly maturing, style exceeding the nutlets 1.5–2 mm.; nutlets in contact, ovate, obtuse, 2.5–3.5 mm. long, with an indistinct thinner margin, surfaces somewhat glossy, dorsally sparingly tuberculate and usually more or less rugose with low, rounded rugae (smooth in forma *spicata*), ventrally nearly smooth, often with a few indistinct tubercles or rugae, scar straight, nearly or quite closed, extending from about ⅕ the distance from the base to about the same distance from the apex.

Distribution: Transition Zone, eastern foothills of the Rocky Mountains, southeastern Wyoming to south-central Colorado; also in North Park, Colorado. Type: "near Denver, Colorado Territory, 1869," *B. H. Smith*.

Specimens examined:

Wyoming: Sheep Mt., Albany Co., June 24, 1925, *Payson & Payson 4248* (R.Mt.); Chug Creek, Albany Co., June 29, 1900, *Nelson 7338* (R.Mt., Pomona, Minn., Mo., U.S., Gray); Telephone Canyon, Albany Co., June 15, 1894, *Nelson 231* (R.Mt., Minn., Mo., U.S., Gray); Laramie Hills, June 13, 1896, *Nelson 1937* (R.Mt., Minn., Mo.); Centennial Valley, June 8, 1895, *Nelson 1267* (R.Mt., Wash.).

Colorado: Walden, June 25, 1925, *Payson & Payson 4253* (R.Mt.); King's Canyon, Jackson Co., June 25, 1925, *Payson & Payson 4291* (R.Mt.); Horsetooth Gulch, June 30, 1893, *Baker* (Pomona); foothills, Larimer Co., May 25, 1895, *Osterhout*

(R.Mt.); Front Range, July 2, 1896, *Crandall* (R.Mt., Wash., Calif., Mont.); Estes Park, July 12, 1904, *Cooper 117* (R.Mt.); St. Vrain Creek, June 9, 1906, *Dodds 1832* (R.Mt.); Estes Park, Aug. 1895, *Osterhout* (Minn.); Boulder, June 24, 1901, *Osterhout 2463* (Pomona, Calif., Gray, Osterh.); between Tolland and Rollinsville, July 8, 1913, *Overholts 10155* (Calif.); near Boulder, June 10, 1905, *Ramaley 1078* (R.Mt.); near Boulder, July 9, 1900, *Ramaley A.107* (R.Mt.); near Boulder, July, 1902, *Tweedy 5223, 5222* (R.Mt.); near Boulder, June, 1903, *Tweedy 5676* (R.Mt.); Georgetown, July and Aug. 1885, *Patterson 110* (Calif., Phila., Mo., U.S., Gray); near Golden, June 24, 1878, *Jones 296* (Pomona); Green Mt. Falls, Ute Pass, Aug. 2, 1892, *Sheldon 216* (U.S.); Colorado Springs, June 2, 1879, *Jones* (R.Mt., Pomona, U.S.); Pikes Peak region, July 27, 1920, *Johnston 2818* (Gray); Artist's Glen, Pikes Peak, Aug. 1, 1901, *Clements & Clements 102* (R.Mt., Minn., Mo., U.S., Gray); mountains n.e. of Canyon City, 1874, *Brandegee 898* (Mo.).

C. virgata is one of the most conspicuous herbaceous plants on the eastern foothills of the Rocky Mountains in eastern Colorado. The strictly erect, rod-like stems with the closely set white flowers are unique. The numerous elongated leaf-like bracts of the inflorescence add to the peculiar appearance and serve to separate the species from its relatives. Its relationship to *C. setosissima* is decidedly problematical. Although it was for a time held to be a variety of *Bradburiana* there is no reason to believe it is really related to that plant.

Additional evidence is at hand to support Macbride's contention (Proc. Am. Acad. **51**: 546. 1916) that *O. spicata* Rydb. is not even deserving of varietal rank. It is simply to be regarded as a form of *virgata*. Thanks to the help of Mr. W. T. Penfound, of the Alpine Laboratory on Pikes Peak, specimens have been examined that prove the existence of typical *virgata* from that region as well as the smooth-fruited form.

Series 3. HUMILAE. Nutlets distinctly and variously roughened on all surfaces. Scar open and triangular, margins sometimes elevated. Corolla tubes never longer than the calyces. Plants of Utah, Nevada, southwestern Idaho, and California. Species 14–19.

14. **C. insolita** (Macbr.) new comb. Plate 26, figs. 35–37.
Oreocarya insolita Macbr. Contr. Gray Herb. **48**: 28. 1916.

Biennial (or short lived perennial?) from a rather slender root; stems one to several, rather stout, erect, 1.5–4 dm. high, abundantly setose and rather coarsely strigose; leaves clustered at the base, spatulate, obtuse, 3–5 cm. long, dorsal surface subtomentose and rather sparsely appressed-setose and pustulate, ventral surface similar but setae smaller and fewer, pustules rather few and small, petioles abundantly long-hairy at the base, otherwise scarcely ciliate; inflorescence mostly confined to the upper ¼ or ½ of the stem, cymes rather few (for the genus) and conspicuously elongating, inflorescence abundantly but rather weakly setose, bracts inconspicuous; calyx densely hirsute, conspicuously setose with rather short weak bristles; sepals in anthesis linear-lanceolate, acute, about 4 mm. long, in fruit about 8 mm. long, exceeding the nutlets by about 4 mm.; corolla white, tube about 3 mm. long, equalling or somewhat shorter than the sepals, crests at the base of the tube well developed, fornices 0.5–1 mm. long, probably yellow, minutely papillose, slightly emarginate, limb about 7 mm. broad, lobes and tube subequal, lobes united for about ¼ their length; fruit broadly ovoid, 1–4 nutlets maturing, style exceeding the nutlets by 1–1.5 mm.; nutlets ovate, obtuse or acute, 4 mm. long, margins in contact or nearly so, acute, surfaces of nutlets dull or slightly glossy, the dorsal more or less carinate, tuberculate, granulo-muriculate and sometimes slightly rugose, ventral surface tuberculate and somewhat rugose, scar narrow but slightly open, the margin showing some tendency to be elevated.

Distribution: lower part of the Upper Sonoran Zone, southern Nevada. Type: Las Vegas, Nevada, May 4, 1905, *L. N. Goodding 2286.*

Specimens examined:

Nevada: Las Vegas, May 4, 1905, *Goodding 2286* (R.Mt., Minn., Mo., Gray, TYPE); Las Vegas, *K. Brandegee* (Calif.); Las Vegas, April 29, 1905, *Jones* (Pomona).

C. insolita is probably most closely related to *C. virginensis* and *C. tumulosa.* The differences between them, which it will be noticed are mostly those of habit rather than of nutlet peculiarities, may be summarized in the following way:

C. tumulosa	*C. insolita*	*C. virginensis*
Perennial.	Biennial.	Biennial.
Stems 1–2.5 dm. high.	Stems 1.5–4 dm. high.	Stems 1.5–4 dm. high.
Leaves setose below, with subappressed bristles.	Leaves inconspicuously setose below with appressed bristles.	Leaves conspicuously setose below with spreading bristles.
Inflorescence narrow, cymes short.	Inflorescence broad, cymes elongating, very numerous, flowers crowded.	Inflorescence broad, cymes elongating, few, and flowers rather distant.
Nutlets slightly carinate.	Nutlets distinctly carinate.	Nutlets distinctly carinate.
Dorsal surface with low indefinite tubercles.	Dorsal surface with short definite tubercles.	Dorsal surface with sharp definite tubercles.

In general appearance this species is very similar to *C. elata* of Grand Junction, Colorado. However, it is doubtful if the two species are closely related.

15. C. virginensis (Jones) new comb. Plate 27, figs. 38–40.

Krynitzkia glomerata var. *virginensis* Jones, Contr. West. Bot. **13:** 5. 1910.

Oreocarya virginensis (Jones) Macbr. Proc. Am. Acad. **51:** 547. 1916.

Biennial from a rather stout taproot; stems 1–many from the base, stout, 15–40 cm. high, conspicuously setose with divaricate bristles; leaves oblanceolate or spatulate, obtuse, 5–12 cm. long, rather sparsely setose, slightly hirsute and distinctly subtomentose on the dorsal surface, abundantly pustulate, ventral surface rather sparsely pustulate, weakly appressed-setose and subtomentose, at times subsericeous; inflorescence extending over ¾ or more of the stem, very floriferous, not interrupted, becoming a broad thyrsus in which the individual cymes are much elongated, densely setose, in age usually fulvous, lower foliar bracts often conspicuous and somewhat reflexed; calyx densely setose, sepals in anthesis lanceolate, about 4 mm. long, acute, in fruit linear,

10–12 mm. long, exceeding the nutlets by about 6 mm.; corolla white, tube 3–4 mm. long, equalling or slightly shorter than the sepals, crests at base of tube well developed, fornices conspicuous, probably yellow, nearly 1 mm. long, oblong, emarginate, conspicuously papillose, limb 6–8 mm. broad, lobes and tube subequal, lobes united for about ⅓ their length; fruit ovoid, 1–2 nutlets usually maturing, style exceeding nutlets by about 1 mm.; nutlets lance-ovate, obtuse, about 4.5 mm. long, margins in contact, acute, surfaces of nutlets somewhat glossy, the dorsal usually distinctly carinate, sharply tuberculate and somewhat rugose, surface between the tubercles uneven, ventral surface very uneven with indeterminate rugae and tubercles, scar narrowly triangular, some tendency evident to an elevated margin.

Distribution: lower part of Upper Sonoran Zone, southwestern Utah, southern Nevada, southeastern California. Type: La Verken, Utah, May 8, 1894, *M. E. Jones 5195a.*

Specimens examined:

Utah: Valley of the Virgin near St. George, 1874, *Parry 173* (Field, N.Y., Gray); Diamond Valley, May 16, 1902, *Goodding 830* (R.Mt., Pomona, Mo., U.S., Gray); Diamond Valley, April 28, 1894, *Jones 5125* (R.Mt., Pomona, Calif., Mo., U.S.); La Verken, May 8, 1894, *Jones 5195a* (Pomona, TYPE, R.Mt., Calif., Mo., U.S.).

Nevada: Muddy Valley, Lincoln Co., May 16, 1906, *Kennedy & Goodding 78* (Calif., Mo., U.S.); Vegas Valley, Lincoln Co., May 1, 1891, *Bailey, Coville & Funston 1888* (U.S.); Las Vegas, *K. Brandegee* (Pomona); Gold Mountain, 1898, *Purpus* (Calif.); Indian Spring, Charleston Mts., May 7, 1906, *Jones* (Pomona); Good Springs, April 30, 1905, *Jones* (Pomona); Tonopah, April 24, 1907, *Jones* (Pomona); Amargosa Desert, April 27, 1907, *Jones* (Pomona).

California: Panamint Canyon, May 4, 1897, *Jones 6728* (Pomona); above Barstow, April 18, 1921, *Jaeger 1113* (Pomona).

C. virginensis is in general appearance more like *C. thyrsiflora* than any other species of the genus. It is not likely to be confused with that species because of the great distance between their ranges. The nutlets of the two species are entirely different, and it seems quite doubtful if they are in reality closely

related. Its nearest relatives are probably *C. tumulosa*, *C. modesta*, and *C. insolita*. The distinguishing characteristics of these species are contrasted under *C. insolita*.

16. **C. tumulosa** (Payson) new comb. Plate 27, figs. 41–43.

Oreocarya tumulosa Payson, Univ. Wyo. Publ. Bot. **1**: 164. 1926.

Long-lived caespitose perennial from a woody root; stems few to many from a branching caudex, rather stout, 10–25 cm. high, hirsute and densely setose with divaricate bristles; leaves numerous near the base, oblanceolate, obtuse, 3–5 cm. long, blade gradually narrowed into a long, slender, scarcely hirsute petiole, lower leaves conspicuously tomentulose, rather sparsely setose with weak, appressed bristles, dorsal surface slightly more pustulate than the ventral; inflorescence extending over ½ to ¾ of the stem, floriferous, rather narrow, uninterrupted, densely setose with yellowish bristles (at least in age), foliar bracts inconspicuous, reflexed; calyx densely divaricate or retrorse-setose, hirsute, sepals in anthesis linear-lanceolate, acute, about 4 mm. long, in fruit 8–10 mm. long, exceeding the nutlets by 4–6 mm.; corolla white, tube 3.5–4 mm. long, equalling or slightly shorter than the sepals, crests at the base of the tube evident but not conspicuous, fornices conspicuous, probably yellow, about 1 mm. long, limb 7 mm. broad, limb and tube subequal, lobes united for about ⅓ their length; fruit asymmetrical, 1–2 nutlets only maturing, style exceeding the nutlets by about 0.5 mm.; nutlet ovate-lanceolate in outline, obtuse, 4 mm. long, very pale in color, dull or slightly glossy, margins in contact, acute, dorsal surface of nutlets with a low but evident medial ridge, indefinitely tuberculate and sometimes indistinctly rugose, ventral surface roughened with indefinite tubercles and rugae, scar triangular, open, short, margin only slightly elevated.

Distribution: Upper Sonoran Zone on or near the Providence Mountains, San Bernardino Co., California. Type: Providence Mts., May, 1902, *T. S. Brandegee*.

Specimens examined:

California: Ivanpah Mts., San Bernardino Co., June 4, 1915, *Parish 10243* (Calif.); Providence Mts., May, 1902, *T. S. Brandegee* (Calif., TYPE); Providence Mts., May, 1892, *T. S. Brandegee*

(Phila.); Barnwell, May 14, 1911, *K. Brandegee* (Pomona, Calif.); vicinity of Bonanza King Mine, east slope of Providence Mts., May 21–24, 1920, *Munz, Johnston & Harwood 4209* (R.Mt., Pomona, Calif.).

This species has been confused with *C. humilis* and *C. nubigena.* The nutlets are quite different from either of those species. Its nearest relatives are probably *C. virginensis*, *C. insolita* and *C. modesta.* It is contrasted with the first two in the discussion of *C. insolita.* From *C. modesta* it differs in the lack of an elevated margin around the scar and by the indefinite roughening on the dorsal surface.

17. C. modesta new name. Plate 27, figs. 44–46.

Krynitzkia depressa Jones, Contr. West. Bot. **13**: 5. 1910, not *Cryptantha depressa* Nelson, Bot. Gaz. **34**: 29. 1902.

Oreocarya depressa (Jones) Macbr. Contr. Gray Herb. **48**: 32. 1916.

Densely caespitose, long-lived perennial from a woody root; stems few to many from the branching caudex which is densely clothed with the leaf-bases of former years, 8–15 cm. high, rather slender, setose with slender, weak bristles; leaves numerous on the crowns of the caudices, spatulate, obtuse, 1.5–4 cm. long, closely tomentose and setose with weak appressed bristles, pustulate on both surfaces, more abundantly on dorsal, petioles about as long as the blades, conspicuously ciliate near the base; inflorescence extending over ½ to ¾ of the stem, narrow, not interrupted, cymules not elongating, rather softly setose-hirsute, foliar bracts inconspicuous; sepals setose-hirsute, linear-lanceolate, acute, in anthesis 3–4 mm. long, in fruit 7–8 mm. long, exceeding the nutlets by 2–3 mm.; corolla white, tube 3–4 mm. long, equalling the sepals, crests at the base conspicuous, fornices probably yellow, rounded, nearly closing the throat, minutely papillose, 0.5–1 mm. long, limb 7–8 mm. broad, lobes equalling or exceeding the tube, united for about ⅓ their lengths; fruit ovoid, 2–3 nutlets usually maturing; nutlets broadly ovate, obtuse or acute, with slight tendency to be carinate, 3–4 mm. long, margins in contact, acute, surfaces of nutlets glossy, the dorsal tuberculate and often more or less rugose, tubercles and rugae (if present)

rounded and rather low, ventral surface deeply rugose and tuberculate, scar triangular, open, margin somewhat inclined to be elevated.

Distribution: Upper Sonoran Zone in southwestern Utah and eastern Nevada. Type: Aurum, Nevada, alt. 7,300 ft., June 20, 1893, *M. E. Jones 6692.*

Specimens examined:

Utah: hills east of Grass Valley, May 17, 1875, *Ward 49* (U.S., Gray); Modena, June 2, 1902, *Goodding 996* (R.Mt., Pomona, Mo., U.S., Gray).

Nevada: Aurum, June 20, 1893, *Jones 6692* (Pomona, TYPE, Mo., U.S.); Muncy, July 6, 1891, *Jones 6713* (Pomona).

This species is perhaps most closely related to *tumulosa, virginensis,* and *insolita.* In general appearance it is not unlike *tumulosa* or some of the varieties of *C. nana.*

18. **C. humilis** (Greene) new comb. Plate 27, figs. 47–49.

Eritrichium glomeratum var. (?) *fulvocanescens* Wats. Bot. King's Exp. 243. 1871.

E. glomeratum var. *humile* Gray, Proc. Am. Acad. **10**: 61. 1875, in part.

Oreocarya humilis Greene, Pittonia **3**: 112. 1896.

O. hispida Nelson & Kennedy, Proc. Biol. Soc. Wash. **19**: 156. 1906. (Type: "Collected in Carson Valley, Ormsby County, Nevada, April 24, 1904," No. *865, G. H. True.*)

O. echinoides Macbride, Contr. Gray Herb. **48**: 31. 1916, not *Krynitzkia echinoides* Jones.

O. Macbridii Brand, Fedde, Rep. Sp. Nov. **19**: 73. 1923. (Type: Mt. Jarbidge, Nevada, July 6, 1912, *Nelson & Macbride 1960.*)

Caespitose perennial; stems 1–several from the woody caudex, rather stout or slender, 10–30 cm. high, setose with rather weak bristles; leaves obovate-spatulate to oblanceolate, 3–8 cm. long, usually obtuse, rather weakly setose with appressed or slightly spreading bristles, the older leaves distinctly tomentose, petioles conspicuously ciliate near the base with long, white, weak hairs, pustules about equally numerous on both leaf-surfaces; inflorescence rather narrow, mostly continuous, extending over upper ½

or ⅜ of the stem, foliar bracts not conspicuous; calyx densely setose with rather slender bristles, sepals in anthesis linear or linear-lanceolate, acute, 4–5 mm. long, in fruit 8–13 mm. long, exceeding the nutlets by 5–8 mm.; corolla white, tube 4–5 mm. long, tube and calyx lobes subequal, crests at the base of the tube small but evident, fornices low (0.5 mm.), rounded, papillose, probably pale yellow, limb 8–10 mm. broad, lobes and tube subequal, lobes united for about ¼ their length; fruit lance-ovoid, all four nutlets commonly maturing, style exceeding the mature nutlets 1.5–2.5 mm.; nutlets ovate-lanceolate to lanceolate, acute or obtuse, 3–4.5 mm. long, margins in contact, acute or obtuse, surfaces of nutlets somewhat glossy, the dorsal often densely muricate, more or less tuberculate and usually rugose, ventral surface rather indistinctly muricate or tuberculate, scar open at the base or nearly closed, no elevated margin.

Distribution: mostly in mountainous parts of southwestern Idaho, Nevada, and northeastern California. Type not designated: "Frequent in the mountains of Nevada and adjacent eastern California: the Californian plant, as collected by Mr. Sonne, having nutlets nearly twice as large as in the more typical form of eastern Nevada, yet otherwise quite the same."

Specimens examined:

Idaho: Hot Hole, e. fork of Bruneau, July 3, 1912, *Nelson & Macbride* (R.Mt.).

Nevada: near Holborn, July 16, 1896, *Greene* (R.Mt., fragment, TYPE in Notre Dame Herb.); Palisade, June 12, 1903, *Stokes* (Calif.); Palisade, June 14, 1882, *Jones* (Pomona); Jarbidge, July 6, 1912, *Nelson & Macbride 1960* (R.Mt., Minn., Mo., U.S., Gray); Jarbidge, July 8, 1912, *Nelson & Macbride 1980* (R.Mt., Minn., Mo., U.S., Gray); Wadsworth, June 16, 1897, *Jones* (Pomona); Monitor Valley, July, 1868, *Watson 853*, in part (U.S., Gray); Coleman Valley, n.w. Nevada, July 29, 1896, *Coville & Leiberg 91* (U.S.); Carson City, May, 1882, *Jones 6732* (Pomona); Carson Valley, April 24, 1904, *True 865* (R.Mt.); Hunter Creek, Washoe Co., May 17, 1907, *Kennedy 1664* (Calif., Mo., U.S.).

California: sandy banks of Truckee River at Verdi, May and June, 1887, *Sonne* (Calif., Mo.); on Truckee River, Placer Co., July, 1886, *Sonne* (Calif.); Squaw Valley on Truckee River, June-

July, 1885–6, *Sonne* (Calif.); Mt. Stanford, Nevada Co., July, 1892, *Sonne* (Calif., Mo.); Susanville, June 28, 1897, *Jones* (Pomona); Castle Peak near the highest point, Nevada Co., Aug. 3, 1903, *Heller* (Phila., Mo., U.S., Gray); Sierra Co., 1874, *Lemmon 165* (Mo.); Castle Peak, 9,000 ft., Aug. 7, 1900, *Leiberg 5294* (U.S.); summit of Sierra Nevada, July 10, 1879, *Kellogg* (Calif.).

Thanks to Dr. J. A. Nieuwland, of Notre Dame University, I am in receipt of fragments from specimens labeled in Dr. Greene's handwriting as *Oreocarya humilis* Greene. No one of these is designated as the type but doubtless they serve to confirm our notion of Greene's concept of this species. Greene used a name proposed by Gray as a variety of *glomerata* and later transferred by him as the major part of *sericea*. *C. humilis*, as we now know it, was a small part of Gray's concept of the var. *humilis* of *glomerata*. However, it seems only reasonable to adopt the name for the species in the sense in which Greene used it. The specimens designated as *humilis* by Greene are as follows:

1. Near Holborn, Nevada, July 16, 1896, *Edw. L. Greene.*
2. Banks of Truckee River, near Verdi, California, April and May, 1889, *C. F. Sonne.*
3. Mt. near Truckee River, 8000 ft., July 18, 1886, *C. F. Sonne 77* (?).

It is always desirable to select a type specimen for every species whenever possible. In the present case the choice definitely falls upon the specimen collected by Dr. Greene near Holborn, Nevada. There are three reasons for this choice. First, Greene describes the nutlets as "rather densely tuberculate but not rugose." This is more characteristic of the specimen from eastern Nevada than of those from California. Second, Greene refers to the form from eastern Nevada as "the more typical form." Third, an author might be expected to select a plant of his own collecting as the center around which his concept is formed rather than one collected by another collector.

In eastern Nevada the boundary between this species and *nana* var. *commixta* seems rather weak. The rugae tend to be reduced to scarcely continuous tubercles or indistinct wrinkles. It was one of these forms that Macbride classified as *nana* var.

commixta. Brand, examining it more critically, noticed the rugae and thinking that it could not be placed in *commixta,* proposed a new species for it—*O. Macbridii.* An examination of a nutlet from Greene's plant from Holborn, Nevada, makes it evident that the elevations are two sizes. The smaller ones we call murications and the larger, tubercles. In neither are the rugae entirely absent. The specific limits between *humilis* and *nana* var. *commixta* are rather uncertain in the eastern Nevada region. It is unfortunate that this intermediate form should have been selected as the type rather than the more different forms from the Sierra Nevada. *Oreocarya Macbridii* is evidently an exact synonym of *C. humilis.*

19. **C. caespitosa** (A. Nels.) new comb. Plate 27, figs. 50–52.
Oreocarya caespitosa A. Nels. Erythea **7**: 65. 1899.

Densely cæspitose, long-lived perennial; stems many from the ends of the numerous caudices, rather slender, 0.5–1 dm. high, weakly setose or hirsute; leaves mainly clustered on the caudices, spatulate to oblanceolate, obtuse or acute, 2–5 cm. long, densely strigose and appressed-setose with little-differentiated hairs, these so densely matted as to give an appearance similar to tomentum, pustules abundant on the lower surface, somewhat fewer above but quite evident in the older leaves; inflorescence narrow, confined to upper ½–¾ of the stem, foliar bracts inconspicuous; calyx subtomentose and shortly setose or hirsute, sepals linear to linear-lanceolate, acute, 3–4 mm. long in anthesis, in fruit 6–7 mm. long, exceeding the nutlets by about 3 mm.; corolla white, tube 3 mm. long, equalling or slightly shorter than the sepals, crests well developed at the base of the tube, fornices low (0.5 mm.), rounded, pale yellow, limb 5–6 mm. broad, tube and limb subequal or the tube slightly longer, corolla lobes united for ¼–⅓ their length; fruit lance-ovoid, less than four nutlets usually maturing (usually 2?), style scarcely, if at all, exceeding the nutlets; nutlets lanceolate, acute, 3–3.5 mm. long, margins in contact, obtuse or acute, surfaces of nutlets white, dull, the dorsal definitely rugose with low, rounded rugae, somewhat tuberculate, these larger elevations surrounded by numerous low, rounded muriculations, the ventral surfaces minutely and rather

indefinitely muriculate, scar extending from the base nearly to the apex, open and narrowly triangular, no elevated margin present.

Distribution: Upper Sonoran and lower part of the Transition Zones in southern Wyoming. Type (as designated in R.Mt. Herb.): Point of Rocks, *A. Nelson 4749*.

Specimens examined:

Wyoming: Rocky Mts., east side, *Nuttall* (Phila.); Cooper Creek, June 5, 1898, *E. Nelson 5448* (R.Mt.); Freezeout Hills, July 10, 1898, *E. Nelson 4497* (R.Mt.); T. B. Ranch, Carbon Co., June 20, 1901, *Goodding 60* (R.Mt.); Ft. Steele, May 25–June 10, 1901, *Tweedy 4260* (U.S.); Ft. Steele, June 16, 1900, *Nelson 7255* (R.Mt., Gray); Point of Rocks, June 15, 1898, *Nelson 4749* (R.Mt., TYPE, U.S.); Point of Rocks, June 19, 1901, *Merrill & Wilcox 617* (R.Mt., U.S., Gray); Red Desert, June 3, 1897, *Nelson 3120* (R.Mt.); Bush Ranch, Sweetwater Co., June 10, 1900, *Nelson 7078* (R.Mt., Pomona, Minn., Mo., U.S., Gray); n.e. corner of Sweetwater Co., July 6, 1926, *Nelson 10696* (R.Mt.); Bitter Creek, June 16, 1898, *Nelson 4772* (R.Mt., Mo., Gray); Green River, June 1, 1897, *Nelson 3072* (R.Mt.); Green River, June 23, 1896, *Jones 6726* (Pomona); red marl hills on Gros Ventre Fork, June 10, 1860, *Hayden* (Mo.); between Eden & Big Piney, July 6, 1922, *Payson & Payson 2578* (R.Mt., Pomona, Mo., Gray); between Opal and Kemmerer, June 19, 1923, *Payson & Armstrong 3223* (R.Mt., Mo., Gray); Fossil, June 12, 1898, *Nelson 4671* (R.Mt.); east of Evanston, June 28, 1922, *Osterhout 6248* (R.Mt.).

When Dr. Nelson first described this species he included in his specific concept specimens of the plant he later described as *Oreocarya cana.* The two are in reality very different in characters of pubescence and range. *C. caespitosa* is perhaps most closely related to *C. modesta* although it is perhaps not very far removed from *C. humilis.* Whatever its exact relationship *caespitosa* is a very definite unit with an isolated range and it is doubtful if any treatment, however large the specific concept, would fail to accord it full rank as a species.

Series 6. BRADBURIANAE. Nutlets always roughened dorsally and distinctly rugose or tuberculate, or both, and often muricate

also. Ventral surfaces smooth or variously roughened. Scar straight, closed or nearly so, margins not elevated. Corolla tubes never longer than the calyx lobes. Species 20–31.

20. C. thyrsiflora (Greene) new comb. Plate 27, figs. 53–55.

Eritrichium glomeratum var. *hispidissimum* Torr. Bot. Mex. Bound. Surv. 140. 1859, at least in part.

Oreocarya thyrsiflora Greene, Pittonia **3**: 111. 1896.

O. hispidissima (Torr.) Rydb. Bull. Torr. Bot. Club **33**: 150. 1906; Fl. Colo. 288. 1906.

O. urticacea Wooton & Standley, Contr. U. S. Nat. Herb. **16**: 166. 1913. (Type: Canyoncito, Santa Fe Co., New Mexico, June 18, 1897, *A. A. & E. G. Heller 3731*).

O. dura Nels. & Macbr. Bot. Gaz. **62**: 144. 1916. (Type: *E. L. Johnston 418*, 1907, Central Colorado).

O. monosperma Osterhout, Bull. Torr. Bot. Club **46**: 55. 1919. (Type: Trinidad, Las Animas Co., Colorado, July 20, 1918, *Osterhout 5754*).

Short-lived perennial (probably sometimes biennial); stems 1–several from the base, rather stout, 2–4 dm. high, densely setose; leaves oblanceolate, obtuse, 4–10 cm. long, densely and rather coarsely strigose, conspicuously pustulate on both leaf-surfaces, sometimes less densely so above, petioles conspicuously and coarsely setose-ciliate; inflorescence broad and round-topped, dense, abundantly setose, cymes much elongating, foliar bracts large but not conspicuous because of the width of the inflorescence; calyx densely setose, sepals in anthesis linear to lanceolate-linear, 3–4 mm. long, acute, in fruit 6–8 mm. long, exceeding the nutlets by about 4 mm.; corolla white, tube 3–4 mm. long, about as long as the sepals, crests at the base of the tube evident, usually well developed, fornices 0.5–1 mm. long, papillose, pale yellow, limb 7–8 mm. across, lobes and tube subequal, lobes united for about ⅛ their length, style exceeding the mature nutlets about 1.5 mm.; nutlets ovate-lanceolate, acute, about 3.5 mm. long, margins in contact, acute or obtuse, surfaces of nutlets somewhat glossy, the dorsal distinctly rugose, usually with a few tubercles, indefinitely and sparsely muriculate, or slightly roughened, scar straight, narrow,margin not elevated.

Distribution: Transition and Upper Sonoran Zones in western Nebraska, southeastern Wyoming, eastern slope of the mountains in Colorado and northern New Mexico. Type: "On the stony hills in southern Wyoming about Cheyenne, Laramie, etc., thence to middle Colorado," *Greene.*

Specimens examined:

Nebraska: War Bonnet Canyon, June, 1890, *Williams* (Mo.); Rush Creek, Deuel Co., July 2, 1891, *Rydberg 255* (Minn., U.S.).

Wyoming: Rocky Mts., Platte, *Nuttall* (Phila.); Pine Bluffs, June 27, 1889, *Bodin* (Minn.); Lower Pole Creek, July, 1856, *H. Engelmann* (Mo.); Guernsey, June 26, 1901, *Nelson 8263* (R.Mt.); Cheyenne, June 30, 1896, *Nelson 1990* (R.Mt., Minn.); 15 miles west of Cheyenne, Aug. 24, 1925, *Payson & Payson 4685* (R. Mt.); Chug Creek, Albany Co., June 29, 1900, *Nelson 7306* (R.Mt., Pomona, Minn., Mo., U.S., Gray); Table Mt., June 30, 1895, *Nelson 1362* (R.Mt.); Laramie, July 8, 1894, *Nelson 418* (R.Mt., U.S., Gray); Sheep Mt., Albany Co., Sept. 2, 1903, *Goodding 2076* (R.Mt., U.S.); Sheep Mt., June 24, 1924, *Payson & Payson 4246* (R.Mt.).

Colorado: Pawnee Buttes, July 8, 1919, *Osterhout 5934* (Gray); Pawnee Buttes, July 1, 1906, *Dodds 2077* (R.Mt.); Livermore, Larimer Co., June 3, 1897, *Osterhout* (R.Mt.); Livermore, July 26, 1913, *Osterhout 4979* (R.Mt.); near Florissant, Aug. 1–8, 1905, *Ramaley 1448* (R.Mt.); Bear Canyon, Colorado Springs, June 25, 1879, *Jones 972* (R.Mt., Pomona, Calif., U.S.); Colorado Springs, June 15, 1896, *Knowlton 35* (U.S.); Pikes Peak, July, 1920, *Johnston 2817* (Gray); Twin Lakes, July, 1873, *Wolf & Rothrock 700* (Phila., U.S.); Granite to Twin Lakes, Lake Co., Aug. 3, 1925, *Smith 3916* (R.Mt.); Granite, July 23, 1889, *Evermann* (U.S.); Canyon City, Sept. 26, 1874, *G. Engelmann* (Mo.); Canyon City, 1877, *Brandegee 4* (Mo.); Canyon City, June 27, 1896, *Osterhout 629* (R.Mt., Osterh.); near Salida, June 27, 1917, *Payson 1014* (R.Mt.); Salida, June 19, 1898, *Baker, Earle & Tracy 13* (R.Mt., Pomona, Minn., Mo., U.S., Gray); South Park, Aug. 3, 1884, *Letterman* (Field); Sangre de Cristo Creek, July 2, 1900, *Rydberg & Vreeland 5704* (R.Mt.); Buena Vista, July 6, 1892, *Sheldon 526* (U.S.); Buena Vista, Aug. 1–2, 1919, *Eggleston 15379* (Field); Trinidad, June 28, 1898, *Osterhout* (R. Mt.);

Trinidad, July 20, 1918, *Osterhout 5754* (R.Mt., Osterh., Gray); near Trinidad, June 17, 1911, *Standley 6036* (U.S.).

New Mexico: Canoncito, Santa Fe Co., June 18, 1897, *A. A. & E. G. Heller 3731* (Minn., Mo., U.S.); Glorieta, June, 1881, *Vasey* (R.Mt., Mo., U.S.); Sierra Grande, Union Co., June 18, 1911, *Standley 6056* (U.S.).

Early collections of this species were very generally referred to *C. Bradburiana.* This was probably due in large part to the fact that the two are rarely found growing together. In southeastern Wyoming where the ranges do overlap and they are seen growing together it is at once evident that they are distinct specifically. The broad inflorescence of *thyrsiflora* is the outstanding distinction of the species, but in addition the flowers of *thyrsiflora* are smaller and the blooming season later than in *Bradburiana.* The author was at one time inclined to refer certain Montana plants with a broad open inflorescence to this species. Later, however, it has seemed evident that they are forms of *C. Bradburiana* or of *C. Sheldonii.*

A careful examination of the type of *Oreocarya dura* makes it quite certain that it is an immature specimen of *C. thyrsiflora.*

21. C. elata (Eastw.) new comb. Plate 28, figs. 56–58.

Oreocarya elata Eastw. Bull. Torr. Bot. Club **30**: 241. 1903.

Perennial, probably short-lived; stem rather stout, one to several, 3–5 dm. high, rather sparsely and loosely strigose as well as hirsute-setose; radical leaves clustered at the base, spatulate, 1.5–3 cm. long, blade often rather abruptly narrowed to the petiole, acute or obtuse, rather coarsely strigose, densely pustulate and appressed-setose on dorsal surface, ventral surface strigose and pustulate, petioles densely covered with long white hairs; cauline leaves linear-oblanceolate, acute, 2–4 cm. long, setae more widely spreading; inflorescence extending over upper ⅓ or ½ the length of the stem, upper cymes elongating, the lower remaining short, the inflorescence then with a tendency to have a broad top, much narrower downwards, abundantly setose with rather weak slender bristles, bracts inconspicuous; calyx abundantly setose with rather weak bristles, sepals in anthesis lanceolate, acute, about 4 mm. long, in fruit about 8 mm. long, ex-

ceeding the nutlets by 2–3 mm.; corolla white, tube about 4 mm. long, equalling the sepals, crests at the base of the tube well developed, fornices nearly 1 mm. high, distinctly papillose, probably yellow, limb about 9 mm. broad, lobes and tube subequal, lobes united for about ⅓ their length; fruit lance-ovoid, all four nutlets usually maturing, style exceeding the nutlets 1–2 mm.; nutlets ovate-lanceolate, acute or obtuse, about 5 mm. long, margins acute, in contact, surfaces of nutlets slightly glossy, the dorsal margined, densely tuberculate and more or less rugose, entire surface minutely and densely papillose, ventral surface similar but less evidently rugose, scar straight, closed, extending from near the base almost to the apex, slightly open and forked at the base, no elevated margin present.

Distribution: Upper Sonoran Zone, near Grand Junction, Colorado. Type: "Collected by the author [*Eastwood*] near Grand Junction, Colorado, on the road to the coal mines, growing on the bare clay hills characteristic of the region, flowering May 15, fruiting June 28, 1892."

Specimens examined:

Colorado: Grand Junction, May 15, 1892, *Eastwood* (N.Y., U.S., Gray); Grand Junction, June 10, 1920, *Osterhout 5996* (R.Mt., Gray, Osterh.).

Although still imperfectly known, there can be no doubt but that this species is very distinct and quite worthy of specific rank. In habital characteristics it resembles *C. insolita* very closely. The nutlet characters of the two species are so different, however, that one doubts any very close relationship between the two. Excellent but immature specimens of the type collection are in the National Herbarium and in the Gray Herbarium.

22. C. sericea (Gray) new comb.

Perennial from a tap root; stems 1–many from the base, 1.5–4.5 dm. high, rather sparsely setose with slender, divaricate bristles; leaves somewhat clustered at the base, spatulate to oblanceolate, usually obtuse, 2.5–10 cm. long, dorsal surface densely strigose and appressed-setose, abundantly pustulate, ventral surface densely and uniformly silky-strigose, rarely, if at all, pustulate; inflorescence extending over ⅔ to ¾ the length

of the stem, in flower narrow, somewhat glomerate, abundantly setose, foliar bracts conspicuous, especially in the young inflorescence; calyx setose, sepals in anthesis linear-lanceolate, acute, 3–4 mm. long, in fruit 7–9 mm. long, exceeding the nutlets by 3–5 mm.; corolla white, tube 2.5–3.5 mm. long, slightly shorter than the sepals, crests at the base of the tube evident or conspicuous, fornices small (about 0.5 mm. high), rounded, papillose, probably always pale yellow, limb 6–8 mm. broad, lobes and tube subequal, lobes united for about ⅓ their length; fruit ovoid or lance-ovoid, 3–4 nutlets commonly maturing, style exceeding the mature nutlets by 0.25–1 mm.; nutlets lanceolate, acute, 2.75–3.5 mm. long, margins in contact, acute, surfaces of nutlets dull, the dorsal sparsely tuberculate and somewhat rugose as well as more or less muriculate, ventral surfaces at least somewhat roughened, usually distinctly muriculate, scar straight, closed or nearly so, extending from near the base to near the apex, no elevated margin present.

Distribution: Upper Sonoran Zone, southern and southwestern Wyoming, northern Colorado, northeastern Utah.

The varieties of *C. sericea* may be distinguished as follows:

Inflorescence becoming rather broad in age due to the elongation of the cymules; leaves oblanceolate; nutlets 3–3.5 mm. long..............*37a.* var. *typica*
Inflorescence usually narrow, even in age; leaves narrowly oblanceolate; nutlets 2.75–3 mm. long..................................*37b.* var. *perennis*

22a. Var. **typica** n. var. Plate 28, figs. 59–61.

Eritrichium glomeratum var. *humile* Gray, Proc. Am. Acad. **10:** 61. 1875, in large part.

Krynitzkia sericea Gray, Proc. Am. Acad. **20:** 279. 1885, in part.

Oreocarya sericea Greene, Pittonia **1:** 58. 1887.

O. argentea Rydb. Bull. Torr. Bot. Club **31:** 637. 1904. (Type: Rifle, Garfield Co., Colo., 1900, *Osterhout 2122*).

O. procera Osterhout, Bull. Torr. Bot. Club **47:** 211. 1920. (Type: Glenwood Springs, Garfield Co., Colorado, June 18, 1899, *Osterhout 1867*).

Stems usually stout, 1.5–4 dm. high; leaves rather broadly oblanceolate, obtuse, 4–10 cm. long; inflorescence becoming rather broad in fruit due to the partial elongation of the cymules; sepals

about 7 mm. long in fruit, exceeding the nutlets by 3–4 mm.; corolla tube about 3 mm. long, limb 6–8 mm. broad; fruit ovoid; nutlets rather broadly lanceolate, 3–3.5 mm. long, rather inconspicuously margined, style scarcely exceeding the mature nutlets, dorsal surface of the nutlets sparsely tuberculate, distinctly rugose and more or less muriculate, ventral surface sparsely muriculate, scar closed or nearly closed, straight.

Distribution: southern Wyoming, northwestern Colorado, and northeastern Utah. Type: Bridger's Pass (Wyoming), 1856, *Henry Engelmann.*

Specimens examined:

Wyoming: Elk Mt., July 1, 1899, *Little & Stanton 179* (Mo.); Bridger Pass, 1856, *H. Engelmann* (Gray, TYPE, Mo.); Pass Creek to Bridger's Pass, 1859, *H. Engelmann* (N. Y., Gray); 11 miles north of Encampment, July 2, 1922, *Payson & Payson 2528* (R.Mt., Pomona, Field, Mo., Gray).

Colorado: Hayden, Routt Co., July 10, 1913, *Osterhout 4940* (R.Mt., Osterh.); Kremmling, Grand Co., June 22, 1907, *Osterhout 3476* (R.Mt., Osterh.); Rifle, June 23, 1900, *Osterhout 2122* (Pomona, N. Y.); Middle Park, July 26, 1876, *Patterson* (Field); Glenwood Springs, June 8, 1920, *Osterhout 5960* (R.Mt., U.S., Gray, Osterh.); Glenwood Springs, June 29, 1895, *Osterhout* (R.Mt.); Grand Junction, May 30, 1921, *Osterhout 6094* (Osterh.).

Utah: Mill Fork, July 7, 1894, *Jones 5607a* (Pomona, Calif., U.S.).

22b. Var. **perennis** (A. Nels.) new comb.

Oreocarya affinis perennis A. Nels. Erythea 7: 67. 1899.

O. perennis Rydb. Bull. Torr. Bot. Club 33: 150. 1906.

Stems rather slender, 1.5–4 dm. high; leaves narrowly oblanceolate, acute or obtuse, 2.5–4.5 cm. long; inflorescence narrow and glomerate even in fruit, cymules scarcely elongating; sepals about 7 mm. long in fruit, exceeding the nutlets by 3.4 mm.; corolla white with pale yellow fornices, tube 2.5 mm. long, limb about 6 mm. broad; fruit lance-ovoid; nutlets narrowly lanceolate, not wing-margined, 2.75–3 mm. long, dorsal surface sparsely tuberculate, more or less rugose, somewhat muriculate, ventral surface rather sparsely muriculate, scar straight, closed.

Distribution: Upper Sonoran Zone, southwestern Wyoming.
Type: Green River, Wyoming, May 31, 1897, *A. Nelson 3035*.

Specimens examined:

Wyoming: between Eden and Big Piney, July 6, 1922, *Payson & Payson 2580* (R.Mt., Pomona, Field, Mo., Gray, Colo.); Green River, June 25, 1895, *Shear 4381* (U.S.); Green River, June 23, 1896, *Jones* (Pomona); Green River, June 14, 1898, *Nelson 4715* (R.Mt., TYPE, Mo., Gray); Green River, May 30, 1897, *Nelson 3035* (R.Mt., U.S.); 21 miles west of Green River, June 19, 1923, *Payson & Armstrong 3206* (R.Mt., Mo., Gray); between Opal and Kemmerer, June 19, 1923, *Payson & Armstrong 3224* (R.Mt., Mo.); Ft. Bridger, July, 1873, *Porter* (Herbarium not recorded); Evanston, July, 1869, *Watson 852* (U.S.).

The name *sericea* has always been a stumbling block in the way of any satisfactory treatment of this group of plants. At the time when it was described (1885) only seven other species had been proposed in this section. These were among the most outstanding units in the genus and it is evident that *sericea*, whatever it was, was different from any of these and so must be retained as a valid species. Because of this necessity all botanists, to treat these plants for the region assigned to *sericea*, had to make some disposition of it. These interpretations have been extremely varied, and herbarium material labeled "*sericea*" has added to the confusion. During the course of the present study it became probable that *sericea*, when it was located, would almost certainly replace some more recently proposed name, since most of the distinguishable forms were treated under recent names and there was left no place for *sericea*—which was a name older than these others.

The problem was evidently to be solved by a careful study of the specimens available to Dr. Gray when he proposed the species and a consideration of the evidence gathered from the published description. The author believes he has reached a satisfactory solution of the problem by following out these lines of research and proposes to restrict the name *sericea* to the plant that has recently been treated as *Oreocarya argentea* Rydb. The evidence on which this conclusion is based is presented in detail in the following paragraphs.

First of all it is useful to summarize the criteria that have governed the case in question.

1. It is necessary to select a type specimen on which to attach the name in the final analysis, since it is evident that more than one species was involved in Dr. Gray's concept. It must be borne in mind that it is rather unfair to force a type specimen concept on work that was done before this method was emphasized as it is at present. In case it can not be shown that Dr. Gray had one plant especially in mind when he described *sericea* then it might be better to discard the name altogether.

2. The type specimen, if one is to be located, must be selected from the material Dr. Gray had at hand when he described *sericea*. Since he based this species in large part, "magna parte," on his earlier variety *humile*, it would seem only reasonable to select the type from specimens which he had previously considered as representing that variety.

3. The type should be represented by a mature and adequate specimen in which the nutlets are developed since these were described and are of the greatest importance in determining the species of this genus.

4. The description of *sericea* as given by Gray should be examined very carefully and the characters emphasized there should belong to the type specimen. These may be summarized as follows: *sericea* is said to differ from *glomerata* in being less hispid and in being perennial rather than annual. It is a many-stemmed plant. The indument is soft, strigose-sericeous, and the setae are short, not very rigid and often appressed. The nutlets are subrugose-tuberculate and oblong-ovate.

5. The range of the species *sericea* is given as follows: "Alpine or subalpine, on mountains from Colorado and Utah to Oregon and Montana and probably in the British Possessions. There are less canescent forms from the Saskatchewan region and also from the higher Sierra Nevada (and uncertain as to the duration of the root) which may belong either to this species or to dwarfed forms of the foregoing." It would seem that Dr. Gray thought of the forms from Saskatchewan, the British Possessions, or from the higher Sierra Nevada as aberrant. The type then should come from some point in the range "alpine or subalpine, on

mountains from Colorado and Utah to Oregon and Montana."

6. Dr. Gray says, "I have adopted one of the two specific names under which this species occurs in Nuttall's collections." Nuttall's specimen should be examined and its identity considered in connection with the specimens and description of *sericea* as given by Gray.

The next point of attack is to examined the herbarium material considered by Dr. Gray as representing his new species. There are in the Gray Herbarium three sheets that bear the notation "*Krynitzkia sericea* Gray" in Dr. Gray's own handwriting. These sheets also bear the designation "Ed. 2. Syn. Fl. N. Amer." Each of these sheets bears several specimens. This material may be described as follows:

Sheet 1 contains 4 specimens:

a. Bridger's Pass, 1856, *H. Engelmann*	= *O. argentea* Rydb.
b. W. side of Wasatch Mts., 1844, *Frémont*	= *O. humilis* Greene, *K. depressa* Jones, or some form of *O. nana* Eastwood. Too immature for certain identification.
c. Clover Mts., Nevada, 1868, *Watson 853*	= *O. humilis* Greene, *K. depressa* Jones, or some form of *O. nana* Eastwood. Too immature for certain identification.
d. Mountain Hot Springs, Yellowstone Park, 1885, *Tweedy 816*	= *C. Bradburiana*.

Sheet 2 contains 3 specimens:

a. Montana Terr. 1867 It also bears the two separate notations in Dr. Gray's handwriting "*E. glomeratum*" and "Probably dwarf *K. glomerata*."	= *C. Bradburiana*.
b. Summit, California, 1871, *Bolander*	= *humilis* or possibly *nubigena*. Specimens immature.
c. Grass Valley, Utah, 1875, *Ward 49*	= *depressa*.

Sheet 3 contains 2 specimens at the present time and probably 5 (including fragments) in Dr. Gray's time:

a. Shinberger's Canyon, S. Montana, 1880, *Watson 287*	= *Sheldonii*. Specimen immature but identification practically certain.

b. A specimen of *Bradburiana* without data. A note by Dr. Gray says "origin uncertain."

c. Pine Creek, Baker Co., Oregon, 1879, *Cusick*. This is not now on this sheet but the piece on which it is mounted fits the remains of sheet 3, and evidently it was attached to sheet 3 in Dr. Gray's time. This is *nubigena*.
d. Another fragment has been located that was probably attached to sheet no. 3. This fragment contains 2 fragmentary specimens and a note in Dr. Gray's handwriting: "Two more dwarf and very sericeous-canescent forms in Herb. Acad. Philad. Nuttall." One of the fragmentary specimens is evidently a bit of the plant we now know as *caespitosa*. It is from a specimen collected by Nuttall.
e. The second specimen on the scrap described above is an immature piece of the plant we now know as *cana* and was collected at Scott's Bluff on May 30, 1858.

If we now list the specimens that may be considered to compete as the type of *sericea* we see that the following species are represented: *argentea*, *humilis*, *depressa*, *nana*, *Bradburiana*, *nubigena*, *Sheldonii*, *caespitosa*, and *cana*. Five of these can be discarded at once. *Bradburiana* must not be considered, since Dr. Gray was separating his species from that and gave good differences between the two, while *nana* must be discarded because no specimen is represented that is mature enough to make identification certain. The species *humilis* can be eliminated because it is represented by no mature specimen and because the specimens from the higher Sierra Nevada were considered aberrant. *Sheldonii* is represented by a single specimen in which the nutlets are quite immature, and *caespitosa* is represented by fragments so scanty that they are only recognizable by association with a better specimen in the herbarium of the Philadelphia Academy. It carries a manuscript name given it by Nuttall which was never published and which is not *sericea*. We now have left for consideration the species *argentea*, *depressa*, *nubigena*, and *cana*.

Earlier in this discussion it was suggested that since Gray's *sericea* was based in large part upon his variety *humile* it would be reasonable to select a type that had been included in his variety when it was published in 1875. If we now examine the specimens of the remaining species we find that the mature specimen of *nubigena*, and the only certain one of that species, was collected in 1879, after the variety was published. We also find that the only certain representative of *depressa* was collected in 1875, the year of the publication of the variety, and so was evidently not at hand when the variety was described since the papers by Dr.

Gray containing this description were presented to the Academy "May 12 and Oct. 13, 1874." We find Dr. Gray's notation "*E. glomeratum, humile*" on only two specimens of the series that has been described. These are on the one from Bridger's Pass (*argentea*) and on the immature one from the "W. side of the Wasatch Mts." This serves to confirm the selection of *argentea* as the center around which Dr. Gray built his variety *humile* and species *sericea.* We have left, however, two species that need further consideration—*argentea* and *cana*—since *nubigena* and *depressa* are eliminated because they did not form a part of Gray's variety *humile.*

The only reason for considering *cana* as a competitor for the name of the species in question is because Dr. Gray said he chose a name under which the species occurs in Nuttall's collections. The plant to which Nuttall gave the manuscript name of *sericea* was undoubtedly the plant we now know as *cana.* Dr. Gray believed this plant to be part of his species *sericea,* but it is evident he did not describe it or have it particularly in mind. He said *sericea* was the same as his var. *humile* in large part. He did not consider Nuttall's *sericea* as typical var. *humile,* as is shown by his comment, "Nuttall collected and gave MSS. names to some very dwarf and silky canescent forms, which appear to belong here." These aberrant forms, we now know as *caespitosa* and *cana.* The description of Gray's *sericea* does not fit *cana.* The pubescence in *cana* is practically uniform and the setae would not have been described "short, not very rigid and often appressed." The nutlets were unknown to Dr. Gray, and if they had been known would not have been described as "subrugose-tuberculate." The range given by Gray for *sericea* is scarcely large enough to include *cana.* Scott's Bluffs, from where he had a specimen of *cana,* is in Nebraska and so hardly to be described as "alpine and subalpine."

By a process of elimination we obtain a type specimen for *sericea* and select a specimen from Bridger's Pass, collected by H. Engelmann, to represent the species in the final analysis. This selection, however, need not be made on a basis of elimination, since the specimen under consideration has many points that argue for its being the plant that Dr. Gray had especially in

mind when the species was described. Since the matter is of so much importance it may be well to recapitulate briefly the reasons why the specimen from Bridger's Pass is held as the type of *sericea.*

1. Of the 8 species that are probably represented on the sheets that Gray had at hand when he described *sericea* there is no numerical preponderance of any one species. The species *argentea* is represented by one specimen and another sheet was undoubtedly present and considered as *sericea,* but in this case the writing was not in Dr. Gray's hand and so was not considered in the search for the type.

2. The specimen of *argentea* is the best one of the series and shows mature fruits as well as flowers.

3. The published description of *sericea* fits the specimen that has been selected as the type.

4. The specimen under consideration formed part of Gray's concept of the variety *humile,* and the species *sericea* is, he says, the same as that, in large part.

5. The range given by Dr. Gray includes the locality in which the specimen by Engelmann was collected.

6. No other species included in Gray's *sericea* has so good a claim to be considered the typical form as does the plant that has been known as *Oreocarya argentea.*

It seems to have been generally assumed that Bridger's Pass is in Montana, and so the effort has been made to search for typical *sericea* in that state. The Bridger's Pass of Henry Engelmann was surely in southern Wyoming, west of the Platte River. This is near the northern limit of the range of *O. argentea* Rydb.

It is possible that further collections of *O. procera* Osterhout and of Jones' plant from Utah may prove them worthy of varietal rank. The author so designated them at one time.

C. sericea, as now understood, is chiefly distinguished by the lack of pustulate hairs on the upper leaf surface and the consequent sericeous appearance of the indument. Dr. Rydberg evidently had quite an erroneous idea of the variety *perennis* when he reported it from North Dakota and Idaho in his flora of the Rocky Mountains.

23. C. aperta (Eastw.) new comb. Plate 28, figs. 62–64.

Oreocarya aperta Eastw. Bull. Torr. Bot. Club **30**: 241. 1903.

Perennial, caudex branched from a woody root; stems several, rather slender, 1–2 dm. high; leaves densely clustered at base and the dilated petioles imbricated, pubescence of upper and lower leaf surfaces similar, sparsely strigose and abundantly pustulate-setose, bristles conspicuous, spreading; radical leaves spatulate to oblanceolate, 3 cm. long, 8 mm. wide; cauline leaves oblanceolate, about as long as the radical leaves but narrower; inflorescence branched from near the base with many spreading, simple or 2-forked spikes, those of all the stems aggregated into a closely branched thyrsus, spikes peduncled, longer than the subtending leaves, pedicels very short, about 0.5 mm. long; calyx densely setose, sepals in anthesis linear or linear-lanceolate, acute, about 3 mm. long, in fruit 8–10 mm. long, exceeding the nutlets about 5 mm.; corolla white, tube 2.5–3 mm. long, equalling or somewhat shorter than the sepals, crests at the base of the tube evident, fornices conspicuously papillose, probably yellow, nearly 1 mm. long, limb about 6 mm. broad, tube and limb subequal, the lobes united for about ¼ their length; fruit ovoid, all four nutlets commonly maturing, style exceeding the nutlets by about 2 mm.; nutlets lanceolate, acute, 2.5–3 mm. long, margins in contact, acute, surfaces of nutlets somewhat glossy, the dorsal tuberculate, more or less rugose and somewhat muriculate, ventral surface irregularly and ambiguously roughened, scar extending from near the base to near the apex, straight, closed, no elevated margin present.

Distribution: Upper Sonoran Zone, Grand Junction, Colorado, June 27, 1892, *Eastwood.*

Specimen examined:

Colorado: Grand Junction, May 17, 1892, *Eastwood* (Calif.).

C. aperta is another species of this genus of which more material is badly needed. Presumably it is distinct from all others but it is so imperfectly known that it is impossible to know to what other species to ally it.

24. C. rugulosa (Payson) new comb. Plate 28, figs. 65–67.

Oreocarya rugulosa Payson, Univ. Wyo. Publ. Bot. **1**: 166. 1926.

Short-lived perennial; stems few to many, unbranched above the base, rather slender, 15–30 cm. high, rather sparsely but conspicuously setose; leaves narrowly oblanceolate or spatulate, obtuse, 2–4 cm. long, strigose-canescent and setose, pustulate hairs abundant on both surfaces, slightly more numerous on dorsal, petioles ciliate with long, rather weak white hairs; inflorescence mostly confined to the upper ¼ or ½ of the stem, cymes elongating, foliar bracts inconspicuous, inflorescence densely setose with long, white, slender hairs; calyx subtomentose and abundantly setose, sepals in anthesis lanceolate, acute, 4 mm. long, in fruit linear-lanceolate, 7–8 mm. long, exceeding the nutlets by about 5 mm.; corolla white, tube 3–4 mm. long, equalling the sepals in anthesis, crests at the base of the tube well developed and conspicuous, fornices nearly closing the throat, well developed, not over 0.5 mm. long, distinctly papillose, probably yellow, limb about 6 mm. broad, tube and limb subequal, lobes united for ⅓ their length; fruit ovoid, all four nutlets usually maturing, style exceeding the mature nutlets 1–1.5 mm.; nutlets lanceolate, subacute, 3 mm. long, margins in contact, acute, surfaces of nutlets somewhat glossy, the dorsal distinctly rugose with rather distant, low rugae, somewhat tuberculate also, ventral surface only slightly uneven, scar straight, extending from near the base almost to the apex, closed above, slightly open near the base, no elevated margin present.

Distribution: Upper Sonoran Zone, western Utah. Type: Fish Springs, Utah, *M. E. Jones*.

Specimen examined:

Utah: Fish Springs, June 4, 1891, *Jones* (R.Mt., TYPE, Pomona, Calif.).

The most outstanding characteristic of this plant is the smooth inner surfaces of the nutlets. It is to be considered a member of the *spiculifera-interrupta-Sheldonii* group of species.

25. C. interrupta (Greene) new comb. Plate 28, figs. 68–70.
Oreocarya interrupta Greene, Pittonia 3: 111. 1896.

Long-lived, caespitose perennial; stems few to many from the branching caudex, rather slender, 3–9 dm. high, rather sparsely strigose and setose with slender white trichomes; radical leaves

tufted on the caudices, oblanceolate, obtuse or acute, 3–5 cm. long, the blade tapering gradually to a hispid-ciliate petiole, lower leaf-surfaces rather densely strigose or subtomentose, setose with subappressed and rather inconspicuous bristles, pustulate, upper surfaces more finely strigose and very inconspicuously setose, pustules minute; stem-leaves similar, reduced and narrower upwards; inflorescence densely setose with white hairs, more or less interrupted, narrow cymes somewhat elongating at the top, stems bearing cymes for ½–⅔ of their length; calyx setose, sepals in anthesis about 3 mm. long, linear or linear-lanceolate, in fruit 6–8 mm. long, exceeding the nutlets by 4–5 mm.; corolla white, tube 3 mm. long, equalling the sepals in anthesis, crests at the base of the tube well developed, fornices probably pale yellow, low, scarcely papillose, limb 5–7 mm. broad, tube and limb subequal or the tube slightly longer, lobes united for ⅓ their length; fruit lanceolate-ovoid, 1–4 nutlets maturing, style exceeding the mature nutlets by less than 1 mm.; nutlets lanceolate, obtuse or subacute, 3 mm. long, margins in contact or nearly so, acute, surfaces of nutlets dull or slightly glossy, the dorsal definitely tuberculate with small tubercles, a few of these elongated on some nutlets, but the nutlets only rarely rugose, indefinitely muriculate, especially toward the apex and the margins, ventral surfaces similar but with fewer tubercles and muriculations, scar straight, extending from near the base to near the apex, closed or nearly so, margin not elevated.

Distribution: Upper Sonoran Zone in northeastern Nevada.

Type: "in open woods some miles east of Wells," *Greene.*

Specimens examined:

Nevada: Park's Station, 25 miles north of Elko, Aug. 4, 1913, *Hitchcock 1005* (U.S.); Elko, Aug. 2, 1913, *Hitchcock 929* (U.S.); Humboldt Wells, Elko Co., July 28, 1908, *Heller 9185* (Mo., N.Y., U.S., Phila.).

This plant is imperfectly known but is apparently most closely related to *C. spiculifera.* From that species it differs in the less conspicuously setose, broader radical leaves, the tuberculate and not rugose nutlets, and the shorter style. It has not been possible to locate the type but specimens from near the type locality agree very well with the original description and there is probably no

doubt but that the species has been correctly identified. No specimens have been seen that were so high as the plants described by Greene. He says "1½ to 3 feet high." The specimens at hand are all about one foot high.

26. C. spiculifera (Piper) new comb. Plate 28, figs. 71–73.

Oreocarya spiculifera Piper, Contr. U. S. Nat. Herb. **11:** 481. 1906.

O. cilio-hirsuta Nels. & Macbr. Bot. Gaz. **55:** 378. 1913. (Type: *Nelson & Macbride 1799*, Minidoka, Idaho, June 23, 1912.)

Long-lived, caespitose perennial; stems few to many from the base, slender, 15–30 cm. high, strigose, hirsute and setose with long slender white hairs; leaves linear-oblanceolate or linear-spatulate, acute or obtuse, 3–7 cm. long, dorsal surface densely strigose and with rather numerous pustulate, spreading setae, ventral surface densely strigose, sparsely setose with somewhat weaker and more closely appressed pustulate hairs, petioles conspicuously long-ciliate; inflorescence on the upper ½ or ¾ of the stem, densely setose with long, white, slender hairs, cymules somewhat elongating, foliar bracts mostly inconspicuous; calyx strigose and densely setose, sepals in anthesis 4–5 mm. long, linear-lanceolate, in fruit 8–10 mm. long, exceeding the nutlets by 6–7 mm.; corolla white, tube 3–4 mm. long, equalling the sepals in anthesis, crests at the base of the tube evident, fornices well developed, at least 0.5 mm. high, scarcely papillose, pale yellow, limb about 7 mm. broad, tube and limb subequal or the tube slightly longer, lobes united for ¼ their length; fruit ovoid, all four nutlets usually maturing, style exceeding the mature nutlets by about 2 mm.; nutlets lanceolate, acute, 3–4 mm. long, margins usually in contact or nearly so, acute or obtuse, surfaces of nutlets dull, the dorsal definitely but narrowly margined, densely muriculate, rugose and sparsely tuberculate, ventral surfaces densely muriculate, sparsely tuberculate and with a few short rugae, scar straight, extending from near the base to near the apex, narrowly open, no elevated margin present.

Distribution: Upper Sonoran Zone of western Washington and south-central Idaho. Type: "collected at Ritzville, Adams County, by *Sandberg & Leiberg* (*No. 164*), June 6, 1893."

Specimens examined:

Idaho: Salmon, June 23, 1920, *Payson & Payson 1768* (R.Mt., Mo., Gray); Arco, June 19, 1893, *Palmer 189* (U.S.); Challis, July 15, 1916, *Macbride & Payson 3223* (R.Mt., Gray); Martin, July 5, 1916, *Macbride & Payson 3039* (R.Mt., Mo., U.S., Gray); Minidoka, June 23, 1912, *Nelson & Macbride 1799* (R. Mt., Mo., U.S., Gray); Shoshone, May 27, 1899, *Saunders 4875* (Mo.); Boise-Payette Project, June 2, 1911, *Macbride 875* (Pomona, R. Mt., Minn., Field, Mo., U.S., Gray); New Plymouth, May 21, 1910, *Macbride 93* (R.Mt.); Weiser, April 26, 1900, *Jones 6673* (Pomona).

Washington: Wilson Creek, eastern Washington, June, 1893, *Sandberg & Leiberg* (Pomona, Minn.); Ritzville, June 6, 1893, *Sandberg & Leiberg 164* (Wash., Calif., Mo., U.S., TYPE, Gray).

C. spiculifera is a fairly well-defined unit characterized by narrow radical leaves with conspicuously setose petioles. The caudex is multicipital and the leaves are very numerous in typical forms. It is likely to be confused with *C. Macounii*, and at one time the author was inclined to unite the two as varieties under one specific name. This process of submergence would lead to such wholesale reductions, however—*Sheldonii, Macounii, spiculifera, interrupta, rugulosa, Bradburiana, sobolifera*—that it seemed unwise. *C. spiculifera* has some contact, too, with *C. nana* var. *Shantzii*. A specimen from southeastern Idaho was examined that looked remarkably like *spiculifera* but the nutlets were uniformly muricate as in the var. *Shantzii*. This intermediate plant might, of course, have been a hybrid.

27. C. celosioides (Eastw.) new comb. Plate 28, figs. 74–76.

Oreocarya celosioides Eastw. Bull. Torr. Bot. Club **30**: 240. 1903.

Long-lived perennial from a stout, woody root; stems 1–several from a leafy caudex which is densely clothed with the broad imbricated petioles of former leaves, stout, 2–4 dm. high, densely setose with stiff divaricate bristles; leaves clustered at the base of the stem—or only the petioles of former leaves remaining to show the basal tuft—spatulate to oblanceolate, usually obtuse, 2–5 cm. long, densely setose with spreading white bristles and

subtomentose, densely pustulate on both surfaces, petioles conspicuously ciliate; inflorescence extending over upper ½ to ⅔ of stem, becoming rather broad due to the elongation of the cymules, densely setose, foliar bracts inconspicuous; calyx densely setose with spreading bristles, sepals in anthesis about 5 mm. long, linear-lanceolate, acute in fruit, about 12 mm. long, exceeding the nutlets by about 8 mm.; corolla white, tube 4–5 mm. long, about as long as the sepals, crests at the base of the tube well-developed, conspicuous, fornices nearly 1 mm. high, probably yellow, slightly papillose, limb about 8 mm. across, lobes and tube subequal, lobes united for ¼ to ⅓ their length; fruit ovoid, 2–4 nutlets maturing, style exceeding the mature nutlets by 2.5–3 mm.; nutlets 4–5 mm. long, ovate-lanceolate, acute, margins acute, almost winged, in contact, surfaces of nutlets dull or slightly glossy, the dorsal conspicuously rugose toward the middle and muriculate toward the edge, somewhat tuberculate also, in the type collection slightly keeled, the ventral surfaces rugose or tuberculate and somewhat muriculate, scar straight, closed, extending from near the base to near the apex, margin not elevated.

Distribution: Upper Sonoran Zone along the Columbia River in Washington and in the drainage of the John Day River in Oregon. Type: "*Thos. J. Howell,* from the banks of the Columbia River, eastern Washington, July, 1881."

Specimens examined:

Washington: Washington Terr. 1883, *Brandegee 996* (Calif., Gray); Klickitat Hills, May, 1888, *Howell 431* (Wash., Calif.); banks of Columbia River, July, 1881, *Howell* (Calif.); Rock Island, Kittitas Co., July 12, 1893, *Sandberg & Leiberg 440* (Wash., Calif., Minn., U.S., Gray); near Columbus, June 10, 1886, *Suksdorf 888* (Calif., Field, Mo., U.S., Gray); Wenatchee, 1895, *Whited* (Wash.); Wenatchee, May 28, 1899, *Whited 1099* (Wash., U.S., Gray).

Oregon: Dalles, May, 1882, *Howell* (Phila.); Mitchell, Aug. 1, 1917, *Lawrence 1030* (U.S.); near Fossil, Gilliam Co., May 29, 1894, *Leiberg 125* (U.S.); Canyon City, July, 1902, *Griffiths & Hunter 170* (U.S.); dry hills near Fossil, Wheeler Co., June 2, 1925, *Henderson 5212* (Mo., Gray); Kimberly, Grant Co., June

24, 1925, *Henderson 5212* (Mo., Gray); dry slope, Clarno, southeast Wasco Co., July 3, 1921, *Peck 10020* (N.Y.).

I would limit this plant to the Upper Sonoran Zone of central Washington and Oregon. This is in essential agreement with Piper in his 'Flora of Washington' except that he includes one plant (*Cotton 359* from the Rattlesnake Hills) which I refer, rather dubiously, to *C. Macounii.* He says that *celosioides* comes from the "Arid Transition" Zone but according to the map of life zones in his 'Flora,' the localities in which *celosioides* are found are all in the Upper Sonoran Zone. The large nutlets and stout stems are the best characters of *celosioides* that may be used to separate it from its nearest allies—*C. Sheldonii* and *C. spiculifera.*

28. **C. Sheldonii** (Brand) new comb. Plate 28, figs. 77–79.

Oreocarya sericea Piper, Contr. U.S. Nat. Herb. **11**: 482. 1906, not *Krynitzkia sericea* Gray.

O. celosioides Macbr. Contr. Gray Herb. **48**: 29. 1916, in part, as to specimens cited, not *O. celosioides* Eastw.

O. glomerata Standley, Contr. U. S. Nat. Herb. **22**: 401. 1921, not *Cynoglossum glomeratum* Pursh.

O. Sheldonii Brand, Fedde, Rep. Sp. Nov. **19**: 73. 1923.

Definitely perennial, rather loosely caespitose; stem rather stout, 2–3 cm. high, abundantly setose with rather slender, divaricate hairs; basal leaves numerous, spatulate to oblanceolate, usually obtuse, 2–4 cm. long, 5–8 mm. broad, abundantly setose with rather weak subappressed hairs, the older leaves distinctly tomentose, pustules present on both leaf surfaces; cauline leaves similar, reduced upwards; inflorescence setose, rather narrow or the branches elongating in age, mainly uninterrupted, extending over ½ to ¾ of the stem, foliar bracts inconspicuous; calyx densely setose, sepals in anthesis linear-lanceolate, acute, 3–5 mm. long, in fruit about 8 mm. long, exceeding the nutlets by 4–5 mm.; corolla white, tube 4 mm. long, subequal to the sepals in anthesis, crests at the base of the tube evident, fornices 0.5 mm. high, probably yellow, papillose, limb 5–10 mm. broad, limb and tube subequal or the tube slightly longer than the limb, lobes united for about ⅓ their length; fruit ovoid or lanceolate-ovoid, all four nutlets commonly maturing, style exceeding the

nutlets by about 2 mm.; nutlets lanceolate, acute or subacute, 3–4 mm. long, margins in contact, acute, surfaces of nutlets slightly glossy, the dorsal tuberculate, usually more or less rugose and obscurely muricate, ventral surface more or less tuberculate; scar straight, extending from near the base to near the apex, closed, no elevated margin present.

Distribution: Transition Zone of western Montana, northern Idaho, eastern Washington, and northeastern Oregon. Type: Deep Creek, Wallowa Co., Oregon, *Sheldon 8315*.

Specimens examined:

Montana: St. Mary Lake, Glacier Nat'l. Park, Aug. 8, 1919, *Standley 17423* (U.S.); Glacier Park Station, July 6, 1919, *Standley 15107* (U.S.); Glacier Park Station, Aug. 15, 1919, *Standley 17594* (U.S.); Great Falls, June 16, 1891, *Williams 109* (Minn., U.S.); Helena, 1891, *E. N. Brandegee* (Calif.); Hallett's Ranch, Aug. 14, 1892, *E. N. Brandegee 17* (Calif.); Helena, June & July, 1892, *Aiton 64* (Minn.); Deer Lodge Valley, July 19, 1905, *Jones* (Pomona); Missoula, June 10, 1922, *Kirkwood 1262* (Mont.); near Missoula, June 12, 1901, *MacDougal 169*, this specimen is intermediate to No. 31 (*C. Bradburiana*) (U.S., Mont., Gray); upland benches, Hamilton, June 16, 1906, *Blankinship 734* (Field, U.S., Mont.); on Madison River, 4300 ft., June 28, 1860, *Hayden* (Mo.); 10 miles east of Monida, June 18, 1899, *A. & E. Nelson 5429* (R.Mt., Mo.); Shinberger's Canyon, southern Montana, July 15, 1880, *Watson 287* (Gray).

Idaho: Kootenai Co., July, 1880, *Sandberg* (Minn.); in the Palouse country and about Lake Coeur d'Alene, June–July, 1892, *Aiton 31* (Minn.).

Washington: Spokane, May 16, 1896, *Piper 2294* (Wash., Gray); Hangman Creek, Spokane, May 23, 1897, *Piper* (Wash.); Spokane River, June 2, 1892, *Henderson 2563* (Wash., Gray); Spokane, June 19, 1913, *Turesson* (R.Mt.); between mouth of Spokane and Colville, 1838–42, *Wilkes 437* (*61*), (Phila.).

Oregon: Deep Creek, Wallowa Co., June 16, 1897, *Sheldon 8315* (N.Y., Mo., U.S.).

This species as here defined is composed of rather different individuals from a large range. Mature specimens are still rather few, and the specific limits are sometimes difficult of location.

The plant is obviously a relative of *C. Bradburiana* in spite of Brand's suggestion that it is closely related to *leucophaea*. From *Bradburiana* it is separated because of the perennial, caespitose base and the western range. Macbride confused it, in part, with *celosioides*. From that species *Sheldonii* may be distinguished by the smaller, differently marked nutlets, the more slender stems, and the more easterly range. It is also likely to be confused at times with *spiculifera*. That plant has narrower leaves that are strongly ciliate-hirsute, a stronger tendency to a multicipital caudex, somewhat different nutlets, and a more southern and eastern range. *C. Macounii* is the other perennial relative of *C. Bradburiana*. That plant is characterized by narrow, strongly setose leaves, while *Sheldonii* has broad, tomentose ones. The range of *Macounii* is more northern than the others. Piper recognized the species as distinct from *celosioides* (and *glomerata*, of course) but supposed it to be *sericea*. To this Macbride makes an interesting comment, "Piper may be justified in distinguishing two species here, but if the material from eastern Washington [*Sheldonii*] represents a species distinct from that of the Columbia Valley [*celosioides*], it cannot bear the name *O. sericea* which must be used to designate a very different plant of the Rocky Mountains." With *sericea* now identified with Rydberg's *argentea*, Macbride's comment is particularly pertinent.

29. C. Macounii (Eastw.) new comb. Plate 29, figs. 80–82.

Eritrichium glomeratum Macoun, Cat. Canad. Pl. **1**: 337–338. 1883, in part.

Oreocarya Macounii Eastw. Bull. Torr. Bot. Club **40**: 480. 1913.

Caespitose, long-lived perennial from a rather slender tap-root; stems slender, 10–20 cm. high, conspicuously setose with divaricate bristles; leaves linear to linear-oblanceolate, 2–5 cm. long, acute or obtuse, conspicuously setose with spreading bristles (particularly on the petioles), leaf-surfaces strigose, more densely pustulate below than above; inflorescence narrow, mainly limited to upper ⅓ or ½ of the stem, densely setose, foliar bracts sometimes rather conspicuous near the base of the inflorescence; calyx densely setose as well as strigose, sepals linear-lanceolate,

acute, about 3 mm. long in anthesis, in fruit 6–7 mm. long, exceeding the nutlets 3–4 mm.; corolla white, tube about 3 mm. long, equalling the sepals, crests at the base of the tube evident but not conspicuous, fornices about 0.5 mm. high, probably yellow, limb 7–9 mm. broad, tube and limb subequal, lobes united for about ⅛ their length; fruit lanceolate-ovoid, all four nutlets commonly maturing, style exceeding the nutlets 1.5–2 mm.; nutlets lanceolate, acute or subacute, 2.5–3 mm. long, margins in contact, acute, surfaces of nutlets dull or slightly glossy, the dorsal rather indeterminately rugose, tuberculate and muriculate, the ventral surfaces indeterminately muriculate and tuberculate, scarcely rugose, scar extending from the base to near the apex, straight, closed except for a very small area at the base, margin not elevated.

Distribution: rocky hills, from southern Saskatchewan, Alberta, and British Columbia into Montana, Wyoming, and Washington. Type: Moose Mountain Creek, Saskatchewan, *John Macoun.*

Specimens examined:

Saskatchewan: Saskatchewan, 1858, *Bourgeau* (Gray); Carlton House, 1827 (?), *Drummond* (Gray); Cypress Hills, June 8, 1884, *Macoun 85007* (Canada); Moose Jaw, June 14, 1903, *Barber 325* (Gray); Moose Jaw, July 7, 1880, *Macoun* (Minn.); Chaplin, June 18, 1896, *Macoun 12800* (Pomona, Field, Canada); Moose Mt. Creek, July 6, 1880, *Macoun* (N.Y., TYPE, U.S.); Wood Mt., June 5, 1895, *Macoun 11819* (Canada); Spy Hill, July 1, 1906, *Macoun 78500* (Canada); Parkby, June 10, 1905, *Palmer* (U.S.); South Saskatchewan, Aug. 14, 1872, *Macoun 17089* (Canada); File Hills, July 2, 1879, *Macoun 17089* (Canada).

Alberta: Medicine Hat, May 31, 1894, *Macoun 5801* (Canada, Gray); Macleod, May 12, 1913, *Moodie* (U.S.); Old Man's River, June 20, 1881, *Dawson 17088* (Canada); Milk River, July 13, 1895, *Macoun 11820* (Pomona, Canada).

British Columbia: Similkamen River, June 8, 1905, *Macoun 76741*[1] (Wash., Field, Canada).

Montana: Baltic, May 30, 1900, *Wilcox 79* (U.S.); Browning,

[1] This specimen is not a typical *C. Macounii* but is intermediate to *C. Sheldonii.*

Sept. 10, 1909, *Jones*[1] (Pomona); Lewis & Clark Nat'l. Forest on Beaver Creek, Aug. 6, 1912, *Saunders*[1] (U.S.); near Helena, June, 1921, *Wooton*[1] (U.S.); Helena, June, 1893, *Starz*[1] (Mo.); Helena, 1886, *Kelsey 102*[1] (Pomona); Helena, June, 1888, *Kelsey*[1] (U.S.); plains about Helena, June, 1887, *Anderson*[1] (Calif., Mo.); Midvale, June 24, 1903, *Umbach 149*[1] (U.S.); Garrison, July 10, 1909, *Jones*[1] (Pomona); Armstead, June 20, 1920, *Payson & Payson 1746*[2] (R.Mt., Mo., Gray).

Wyoming: between Sheridan and Buffalo, June 15–July 15, 1900, *Tweedy 3570* (R.Mt.); West Hurlbut Creek, Big Horn Mts., June 15, 1909, *Willits 92* (R.Mt.).

Washington: north side Rattlesnake Mts., May 11, 1901, *Cotton 359*[1] (R.Mt., Wash., Mo., Phila., U.S., Gray).

C. Macounii, although readily distinguishable in its extreme form as it is found on the Canadian plains, has rather doubtful specific limits in the south where it comes in contact with the ranges of related species. It is likely to be confused with *C. spiculifera*, but the author believes that it is in reality more closely related to *C. Bradburiana* and *C. Sheldonii*. It is certain, however, that all four species are too close for entire convenience and all may be found to merge. Its right to specific recognition rests on its narrow leaves, abundant and conspicuous setae, and small, rather ambiguously marked nutlets.

30. C. sobolifera Payson[3] Plate 29, figs. 83–85.

Long-lived multicipital perennial; stems branching from the

[1] These specimens are not typical *C. Macounii*. They are from a unified area in western Montana and are distinctly aberrant. In some ways they are intermediate between *Macounii* and *Sheldonii*, in others they are more like *C. Bradburiana*. Further study may make it seem desirable to separate them varietally from *Macounii* on the basis of a more robust habit.

[2] This is not a typical *C. Macounii*, but is intermediate to *C. Sheldonii*.

[3] **Cryptantha sobolifera** sp. nov., perennis; caulibus sterilibus prostratis ad apicem foliatis, caulibus floriferis 15–18 cm. altis hirsutis et setosis; foliis obovato-spathulatis obtusis 1.5–3.5 cm. longis dense strigosis aut subtomentosis et insigniter setoso-hirsutis supra et subter pustulosis, basis in petiolas gracilibus gradatim attenuatis; thyrsis angustis longo-setosis; sepalis lineari-lanceolatis 3.5 mm. longis, fructiferis 6–8 mm. longis quam nuculis 4 mm. longioribus; corolla alba, tubo 3–4 mm. longo, calycem non superante, limbo 7 mm. lato; stylo nuculas 1.5–2 mm. superante; nuculis non nitidis ovato-lanceolatis subacutis 3 mm. longis, facie exteriore tuberculosa aut leviter rugosa, faciebus ventralibus fere laevibus, sulco angusto recto, margine non edita.—Collected by *M. E. Jones*, Upper Marias Pass, Montana, Sept. 10, 1909 (Pomona, TYPE).

root and apparently more or less prostrate or creeping, some of them sterile and terminating in a cluster of leaves (soboles), fertile stems 15–18 cm. high, hirsute and strigose; leaves clustered on the ends of the sterile branches and scattered on the stem, obovate-spatulate, obtuse, 1.5–3.5 cm. long, gradually narrowed to a slender petiole, dorsal and ventral surfaces similar, densely strigose or subtomentose and conspicuously setose-hirsute with long, slender, white bristles, both surfaces pustulate, petioles densely setose-ciliate; inflorescence on the upper ⅓ or ½ of the stem, cymules slightly elongating, foliar bracts inconspicuous, inflorescence densely long-setose; calyx strigose as well as setose, sepals in anthesis 3.5 mm. long, linear-lanceolate, in fruit 6–8 mm. long, exceeding the nutlets by about 4 mm.; corolla white, tube 3–4 mm. long, equalling the sepals in anthesis, crests at the base of the tube forming a united ring, conspicuous, fornices nearly 1 mm. long, yellow, emarginate, papillose, limb about 7 mm. broad, tube and limb subequal, lobes united for ⅓–½ their length; fruit ovoid, all four nutlets commonly maturing, style exceeding the mature nutlets by 1.5–2 mm.; nutlets ovate-lanceolate, subacute, 3 mm. long, margins in contact, acute, surfaces of nutlets dull, the dorsal rather sparsely tuberculate, sometimes more or less rugose, indistinctly muricate, the ventral nearly smooth or with a few indefinite tubercles, scar straight, extending from near the base to near the apex, closed, margins not elevated.

Distribution: Canadian Zone, northwestern Montana. Type: Upper Marias Pass, Montana, *M. E. Jones*.

Specimens examined:

Montana: Cottonwood Creek, Central Montana, July 30, 1896, *Flodman 748* (N.Y.); Upper Marias Pass, 6,000 ft. alt., Sept. 10, 1909, *Jones* (Pomona, TYPE).

It is with much hesitation that the author describes new species in the *Bradburiana* group. The specimens cited for this species are so aberrant, however, that it has been impossible to assign them to any known species. It is very probable that further collections in the mountains of Montana will show this plant to be an important and distinct unit of this perplexing alliance. The curious development of sterile, creeping stems or soboles

indicates a habitat on loose earth or gravel slides. The label on the type collection bears the statement, "Upper Temperate Life Zone." This is defined by Jones as the spruce belt. The plant is evidently one of the very few members of the genus that inhabits a subarctic region.

31. C. Bradburiana Payson new name. Plate 29, figs. 86–88.

Cynoglossum glomeratum Pursh, Fl. Am. Sept. **2**: 729. 1814, not *Cryptantha glomerata* Lehm.

Myosotis glomerata (Pursh) Nutt. Fl. Am. Sept. **2**: 729. 1814.

Rochelia glomerata (Pursh) Torr. Ann. Lyc. N. Y. **2**: 226. 1828.

Eritrichium glomeratum (Pursh) DC. Prodr. **10**: 131. 1846.

Krynitzkia glomerata (Pursh) Gray, Proc. Am. Acad. **20**: 279. 1885.

Oreocarya glomerata (Pursh) Greene, Pittonia **1**: 58. 1887.

O. affinis Greene, Pittonia **3**: 110. 1896 (Type: "sandy hills near Red Buttes, Wyoming, 5 July, 1896," *Greene*), not *Cryptantha affinis* (Gray) Greene.

Krynitzkia pustulata Blankinship, Montana Agr. Coll. Sci. Studies, Bot. **1**: 96. 1905, not *Cryptantha pustulosa* (Rydb.) Payson.

Oreocarya perennis Rydb. Fl. Rocky Mountains, 722. 1917, in part, not *O. affinis perennis* A. Nels.

Biennial, or short-lived perennial (?) from a tap root; stems rather stout, simple or branched from the base, if branched from the base then one stem usually exceeding the others, stems 1.5–3.5 dm. high, coarsely setose with divaricate bristles; leaves forming a rosette at the base the first year, radical leaves spatulate to oblanceolate or the outermost almost obovate, obtuse, 2–5 cm. long, cauline leaves somewhat narrower and longer, pubescence similar on both leaf surfaces, setose with spreading bristles and subtomentose, abundantly pustulate; inflorescence rather narrow, somewhat glomerate, extending over upper ⅔ or ¾ of the stem, foliar bracts near the base of the inflorescence conspicuous and longer than the cymules in the young inflorescence; calyx densely setose and hirsute, sepals linear-lanceolate, acute, in anthesis about 4 mm. long, in fruit 8–10 mm. long, exceeding the nutlets about 5 mm.; corolla white, tube 3–4 mm.

long, equalling the sepals, crests at the base of the tube conspicuous and well developed, fornices low, rounded or emarginate, about 0.5 mm. long, papillose, pale yellow, limb about 10 mm. broad, lobes and tube subequal or the lobes slightly longer than the tube, lobes united for about ⅓ their length; fruit ovoid, all four nutlets usually maturing; style exceeding the mature nutlets by about 1.5 mm.; nutlets dull or slightly glossy, margins acute, in contact, the dorsal surface of nutlets more or less rugose-tuberculate and with at least a few muriculations, ventral surface indefinitely tuberculate or rugose and somewhat muriculate, scar straight, closed, extending from near the base to near the apex, no elevated margin present.

Distribution: Upper Sonoran and Transition Zones, southern Alberta, North Dakota, western South Dakota and Nebraska, Montana, Wyoming, and northeastern Colorado. Type: "in Upper Louisiana," *Bradbury*. Bradbury collected this plant at the Big Bend of the Missouri in what is now South Dakota.

Specimens examined:

Alberta: Lethbridge, June 5, 1894, *Macoun 5802* (Mo., Canada, Gray).

North Dakota: Pembina, *Havard* (U.S.); Minot, June 5, 1908, *Lunell* (U.S.); Glen Ullin, June, 1891, *Holzinger 6* (U.S.); Medora, July 17, 1891, *Waldron* (R.Mt.); N. W. Territory, *Nicollet 374* (Phila.); Marmarth, June 15, 1914, *Moyer 453* (Minn.).

South Dakota: bluffs of Missouri River, Walworth Co., June 15, 1909, *Moyer* (Minn.); Missouri Valley near Ft. Pierre, June 25, 1839, *Geyer* (U.S.); Ft. Meade, June 9, 1887, *Forwood 272* (U.S.); "Louisiana," *Bradbury* (Phila.); Interior, Stanley Co., June 5, 1914, *Over 6188* (U.S.); White River, Washington Co., Aug. 5, 1914, *Over 6185* (U.S.); Date, Perkins Co., June 1, 1912, *Visher 587* (R.Mt.); Short Pines, Harding Co., June 9, 1911, *Visher 431* (R.Mt.); Cone Hills, Harding Co., July 8, 1920, *Over* (U.S.); Crook, July 23, 1910, *Visher 295* (R.Mt.); 8 miles north of Belle Fourche, Butte Co., June 11, 1916, *Eggleston 12520* (U.S.); Belle Fourche River, June 2, 1894, *Bailey 14* (U.S.); Piedmont, June, 1895, *Pratt* (R.Mt., Minn.); Rockerville, Black Hills, June 15–30, 1909, *White* (Mo.); Hot Springs, June 13, 1892, *Rydberg 893* (U.S.).

Nebraska: Lavaea, July 14, 1898, *Bates* (R.Mt.); Hay Springs, June 6–7, 1901, *MacDougal 60* (Mont.); Ft. Robinson, July, 1891, *Bates* (Minn.); Belmont, July 24, 1889, *Webber* (Mo.); Warbonnet Canyon, *Williams* (U.S.).

Montana: Custer, May 16, 1890, *Blankinship* (R.Mt., Mo.); Livingston, June 8, 1906, *Blankinship 372a* (Pomona, Mo.); Wreck Creek, Sweet Grass Co., June 15–19, 1912, *Eggleston 7959* (U.S.); Greycliff, Sweet Grass Co., May 15–31, 1912, *Eggleston 7838* (U.S.); Livingston, June 7, 1901, *Scheuber* (Minn., U.S.); Bozeman, May 19, 1900, *Moore* (Calif.); Bozeman, June 16, 1905, *Blankinship 373* (U.S.); Sedan, June 11, 1901, *Jones* (R.Mt.); mouth of Shield's River, June 6, 1883, *Scribner 174* (Phila., Gray); near Jefferson City, June 27, 1883, *Scribner 174* (U.S.); Park Co., 1889, *Tweedy* (U.S.); near Pony, July 8, 1897, *Rydberg & Bessey 4882*[1] (R.Mt., Wash., Minn., U.S., Mont., Gray); Spanish Basin, Gallatin Co., June 23, 1897, *Rydberg & Bessey 4883*[1] (R.Mt., Wash., Minn., U.S., Gray); Park Co., 1889, *Tweedy* (U.S.).

Wyoming: Cruse Creek, Sheridan Co., July 6, 1909, *Willits 236* (R.Mt.); hills east of Sheridan, June 17, 1912, *Sharp 132* (R.Mt.); between Sheridan and Buffalo, June 15–July 15, 1900, *Tweedy 3569* (R.Mt.); south of Buffalo, July 24, 1926, *Nelson 10741* (R.Mt.); 40 miles west of Cody, Aug. 31, 1922, *von Schrenk* (Mo.); Mammoth Hot Springs, June, 1887, *Tweedy 816* (Field, U.S.); Cheyenne River, *Williams* (R.Mt., Gray); Wind River, July 14, 1881–82, *Forwood* (U.S.); head of Middle Fork of Powder River, July 18, 1901, *Goodding 287* (Pomona, R.Mt., U.S., Gray); well on Salt Creek Road, Natrona Co., July 9, 1901, *Goodding 230* (R.Mt., Mo., U.S., Gray); Birds Eye, June 24, 1910, *Nelson 9355* (R.Mt., Minn., Gray); Birds Eye, June 20, 1910, *Nelson 9411* (R. Mt., Minn., Gray); Hartville, June 30, 1901, *Nelson 8319* (Pomona, R.Mt., Mo.); Uva, July 10, 1894, *Nelson 388* (Pomona, R.Mt., Minn., Mo., U.S., Gray); Chug Creek, Albany Co., July, 1900, *Nelson* (R.Mt.); Laramie Hills, June 16, 1894, *Nelson 255* (U.S., Gray); Sheep Mt., Albany Co., June 24, 1925, *Payson & Payson 4247* (R.Mt.); Laramie

[1] *Rydberg & Bessey 4882 and 4883* are not typical *C. Bradburiana* but are intermediate to *C. Sheldonii.*

Hills, June 18, 1896, *Nelson 1956* (Pomona, R.Mt., Minn., Mo.); Rock River, June 18, 1901, *Goodding 29* (Pomona, R.Mt., Field, U.S., Gray); Red Buttes, June 18, 1891, *Buffum 640* (R.Mt.); Sand Creek, Albany Co., May 31, 1900, *Nelson 6961* (Pomona, R.Mt., Mo., U.S.); Ft. Steele, June 16, 1907, *Nelson 9045* (R.Mt., Minn., Mo., Gray); Ft. Steele, June 18, 1898, *Nelson 4837* (R.Mt.); Ft. Steele, June 16, 1900, *Nelson 7248* (Pomona, R.Mt., Minn., U.S., Gray); Ft. Steele, May 25–June 10, 1901, *Tweedy 4261* (U.S., Gray); Tipton, June 17, 1898, *Nelson 4788* (R.Mt.); near Table Rock in Red Desert, July 5, 1926, *Nelson 10700* (R.Mt.).

Colorado: Pawnee Buttes, July 8, 1920, *Osterhout 5927* (R.Mt., U.S., Gray, Osterh.).

C. Bradburiana was the first species of this genus to be described and probably also the first species to find its way into herbaria. This was due very largely to its wide distribution in an accessible part of the western United States. Because of the priority of this species and the homogeneous nature of the genus as a whole, very many specimens have been determined as *glomerata* (i.e., *Bradburiana*) that are in reality quite different plants. A number of varieties of this species have been described from time to time that are equally far removed from *glomerata* as it is here understood. Indeed the plants most closely related have been described in recent years and have been proposed and maintained as species since their introduction into scientific literature.

The specific concept of *Bradburiana* and its allies that has been adopted in the present paper is too small for entire satisfaction. With a more inclusive concept the following units would be recognized as varieties only: *sobolifera, celosioides, Macounii, interrupta, spiculifera, Sheldonii,* and possibly *rugulosa.* This reduction of specific units is not accomplished in the present paper for a number of reasons. In the first place the smaller units are mostly satisfactory in the sense that the intermediates are few and the geographical ranges isolated and consistent. In the second place the binomials are somewhat more convenient and the segregates have been previously maintained by other authors as species. In the third place if aggregation proceeded to the point indicated above, there would be good reason to extend the

specific boundaries further and include *humilis*, *sericea*, and *aperta*. From that it would be only a step to include *nana* and its allies, and so the one species would come to contain a large proportion of the units in the genus. In other words, by maintaining a smaller specific concept than is entirely satisfactory, the various units in the genus are kept more nearly uniform in degree of difference from one another and when one commences to aggregate species, it is difficult to stop and the result is not satisfactory because the species retained are of such very different values.

The greatest difficulty comes in delimiting *Bradburiana*, *Sheldonii*,and *Macounii*. In western Montana these forms are very perplexing and much work yet remains to be done before an entirely satisfactory solution can be reached. *Sheldonii* is distinctly and conspicuously perennial and caespitose, while *Bradburiana* is typically biennial and solitary. The comparatively few intermediates that have come to hand have been cited with the species they seemed most to resemble. *Macounii* is distinctly perennial but has very narrow leaves. This is in great contrast with *Sheldonii* but in a few cases it has been difficult to place a particular plant in one species or the other. Only one segregate of *Bradburiana*, in the limited sense, has ever been proposed, namely, *O. affinis* Greene. The present author can see no reason for maintaining this. Macbride (Contr. Gray Herb. 48: 30. 1916) quotes Dr. Nelson concerning the validity of *affinis* over *glomerata* (i.e., *Bradburiana*). It has become evident that Nelson was contrasting *C. Bradburiana* and *C. thyrsiflora* and so the differences given do not relate to the present question. From Macbride's correspondence, which is at hand, it is certain that he maintained *affinis* almost entirely on Nelson's judgment.

It is unfortunate to have to substitute an unfamiliar name for a familiar one but since *Cryptantha glomerata* Lehm., which is a valid South American species and the type of the genus *Cryptantha*, was described long ago, there remains no other alternative if *Oreocarya* is merged in *Cryptantha*.

The name is given in honor of the first collector of the species, who, it seems, fared rather badly in the matter of scientific recognition for his many hardships and privations.

Series 4. Nanae. Nutlets conspicuously muricate, in some species also somewhat rugose. Scar with at least a tendency to be open and so triangular at the base. Species 32–38.

32. C. nana (Eastw.) new comb.

Oreocarya nana Eastw. Bull. Torr. Bot. Club **30**: 243. 1903.

Perennial, more or less densely caespitose; stems 1–many from a branching caudex, rather slender, 5–25 cm. high; leaves spatulate to oblanceolate, usually obtuse, 1–5 cm. long, ventral surface more or less pustulate but somewhat less abundantly so than the dorsal surface; inflorescence usually rather narrow, cymules usually not elongating, foliar bracts not conspicuous; sepals in anthesis linear to linear-lanceolate, acute, 3.5–5 mm. long, in fruit 7–10 mm. long, exceeding the nutlets by 3–4 mm.; corolla white, tube about 3 mm. long, usually distinctly shorter than the calyx lobes in anthesis, crests at base of tube conspicuous or nearly obsolete, fornices low (less than 1 mm.), rounded, more or less papillose, probably yellow, limb 7–10 mm. broad, lobes united for nearly ⅓ their length; fruit lance-ovoid to ovoid, 1–4 nutlets maturing, margins regularly in contact, acute or obtuse; nutlets lanceolate to ovate-lanceolate, acute, dorsal, and usually the ventral surfaces also, densely and uniformly muriculate, not rugose nor tuberculate, scar slightly open at least, and so more or less triangular, no elevated margin evident.

Distribution: Upper Sonoran Zone of western Colorado, southeastern Idaho, Utah, and eastern and southern Nevada.

The varieties of *C. nana* may be distinguished as follows:

Stems 15–25 cm. high; leaves rather sparsely subtomentose and setose; styles 0.5–1 mm. longer than the mature nutlets; central and western Utah and eastern Nevada.................................*32a.* var. *commixta*

Stems 10–20 cm. high; leaves densely tomentose and appressed-setose; styles scarcely exceeding the mature nutlets; north-central Utah and southeastern Idaho.....................................*32b.* var. *Shantzii*

Stems 10–15 cm. high; leaves densely tomentose and appressed-setose; calyx very densely setose and tomentose; styles exceeding the mature nutlets by 0.5–1 mm.; south-central Utah to southeastern Nevada..........*32c.* var. *ovina*

Stems 5–12 cm. high; leaves coarsely strigose and setose; calyx densely setose but scarcely tomentose; styles not exceeding the mature nutlets; western Colorado to northeastern Utah...........................*32d.* var. *typica*

32a. Var. commixta (Macbride) new comb.

Oreocarya commixta Macbride, Contr. Gray Herb. **48**: 33. 1916.

Perennial; stems 15–25 cm. high; leaves spatulate, obtuse, 3–5 cm. long, setose with subappressed or spreading bristles, strigose or subtomentose; inflorescence rather broad, cymules somewhat elongating, foliar bracts not conspicuous; calyx densely setose but scarcely tomentose, in fruit showing some tendency to break away together with the pedicel; style exceeding the mature nutlets by 0.5–1.0 mm.

Distribution: Upper Sonoran Zone, central Utah and eastern Nevada. Type: sandy slides, Juab, Utah, June 9, 1902, *Goodding 1074*.

Specimens examined:

Utah: Price, June 11, 1900, *Stokes* (Calif.); Belknap, June 12, 1900, *Stokes* (Calif.); Juab, June 9, 1902, *Goodding 1074* (R.Mt., Mo., U.S., Gray, TYPE); Vermilion, June 4, 1901, *Jones* (Pomona); Monroe, May 12, 1899, *Jones* (Pomona); Detroit, near Oasis, May 26, 1891, *Jones 6698* (Pomona); Clifton, June 19, 1891, *Jones 6699* (Pomona); Desert Mts., n. w. of Oasis, May 20, 1891, *Jones 6700* (Pomona); Detroit, May 26, 1891, *Jones* (Pomona); Granite Mts., Tooele Co., June 7, 1900, *Jones 6705* (Pomona).

Nevada: Furber, e. Nevada, June 9, 1891, *Jones* (Pomona); Ferguson Spring, June 14, 1900, *Jones 6706* (Pomona).

32b. Var. Shantzii (Tidestr.) new comb. Plate 29, figs. 89–91.

Oreocarya Shantzii Tidestr. Proc. Biol. Soc. Wash. **26**: 122. 1913.

O. dolosa Macbr. Contr. Gray Herb. **48**: 32. 1916. (Type: College Bench, Logan, Utah, June 4, 1909, *Charles Piper Smith 1605*).

Long-lived, caespitose perennial; stem 10–20 cm. high; leaves spatulate, obtuse, 2–5 cm. long, tomentose and appressed-setose with slender more or less appressed bristles; inflorescence usually narrow, cymules only slightly elongating, lower foliar bracts rather conspicuous in the young inflorescence; calyx densely setose and subtomentose; styles scarcely exceeding the mature nutlets.

Distribution: Upper Sonoran Zone, central to northern Utah and southeastern Idaho. Type: College Bench, Logan, Cache County, Utah, June 4, 1909, *Charles Piper Smith 1605*.

Specimens examined:

Idaho: Pocatello, June 15, 1893, *Palmer 598* (U.S.); Pocatello, spring of 1921, *Soth P-9* (R.Mt.); Pocatello, May 17, 1909, *Slaughter 7* (R.Mt.); Soda Springs, June 22, 1892, *Mulford* (Minn., Gray); Nouman, June 5, 1913, *Schoper 28* (R.Mt.); Montpelier, May 15, 1910, *Macbride 2* (R.Mt., Wash., Calif., Minn., Field, U.S., Gray).

Utah: Logan, May 12, 1909, *Smith 1573* (R.Mt.); Logan, June 4, 1909, *Smith 1605* (R.Mt.); Robinson, June 26, 1909, *Jones* (Pomona); Salt Lake Co., May 15, 1903, *Garrett 266* (R.Mt., Gray); Salt Lake City, May 14, 1906, *Garrett 1737* (U.S.); benches near Salt Lake, May 15, 1900, *Stokes* (Calif.); Salt Lake City, May 20, 1900, *Stokes* (Minn., U.S.); Tintic Junction, May 9, 1910, *Jones* (Pomona); City Creek Canyon, April 28, 1889, *Jones* (Pomona); City Creek Canyon, May 19, 1880, *Jones 6719* (Pomona); Garfield, June 30, 1889, *Jones 6709* (Pomona); City Creek, Salt Lake Co., April 20, 1880, *Jones* (R.Mt.); City Creek Canyon, May 5, 1880, *Jones 1692* (R.Mt., Calif., U.S.); Grant's Station, south of Great Salt Lake, *Kearney & Shantz 3098* (U.S., TYPE); Ft. Douglas, Oct. 12, 1909, *Clemens* (R.Mt.); near Emigration Canyon, April 22, 1908, *Clemens* (Gray); Springville, 4400–5000 feet, May 17, 1913, *Hill* (Mo.); Cottonwood, Johnson's Pass, Tooele Co., June 6, 1900, *Jones* (Pomona); Nephi, April 25, 1910, *Jones* (Pomona); 3 miles south of Redmond, Sevier Co., May 31, 1915, *Eggleston 11132* (U.S.).

32c. Var. ovina new var.[1]

Densely caespitose, long-lived perennial; stems 10–15 cm. high; leaves spatulate or oblanceolate, obtuse, 2–4 cm. long, tomentose and appressed-setose with rather weak bristles; inflorescence narrow, or in age somewhat open due to the slight elongation of the cymules, lower foliar bracts scarcely conspicuous; calyx densely setose and tomentose; styles exceeding the mature nutlets by 0.5–1 mm.

[1] **Cryptantha nana var. ovina** Payson var. nov., perennis caespitosa; caulibus 10–15 cm. altis; foliis spathulatis aut oblanceolatis tomentosis et adpresse setulosis; sepalis dense tomentosis; nuculis muriculatis; stylo nuculas 0.5–1 mm. superante. —Collected by *Georgia H. Bentley*, in vicinity of Currant, Nye County, Nevada, June, 1916, (R. Mt., TYPE).

Distribution: Upper Sonoran Zone, southern Utah, and southern Nevada. Type: vicinity of Currant, Nye County, Nevada, June, 1916, *Georgia H. Bentley*.

Specimens examined:

Nevada: Wa Wa, June 25, 1906, *Jones* (Pomona); near Currant, June, 1915, *Bentley* (R.Mt., TYPE, Mo.); Charleston Mts., 1898, *Purpus 6070* (U.S.).

The variety *ovina* is most nearly related to the variety *Shantzii* and is distinguished from it chiefly by the more woolly leaves and calyces and the lower, more caespitose habit. From material at hand it would seem that the styles exceed the mature nutlets more in *ovina* than *Shantzii*.

32d. Var. **typica** n. var.

Oreocarya nana Eastw. Bull. Torr. Bot. Club **30**: 243. 1903.

Long-lived, densely caespitose perennial; stems 5–12 cm. high; leaves narrowly oblanceolate, 1–3 cm. long, setose with spreading bristles, rather coarsely strigose also; inflorescence narrow, cymules not elongating, foliar bracts inconspicuous; calyx densely setose and hirsute but scarcely tomentose; styles not exceeding the mature nutlets.

Distribution: Upper Sonoran Zone, western Colorado, and northeastern Utah. Type: "Collected by the author (*A. Eastwood*) near Grand Junction, Colorado, on the mesa above the Gunnison River, May 17, 1892."

Specimens examined:

Colorado: DeBeque, June 9, 1920, *Osterhout 5980* (R.Mt., U.S., Gray, Osterh.); Grand Junction, June 11, 1920, *Osterhout 6010* (Gray, Osterh.); near Grand Junction, May–Oct., 1898, *Purpus* (Calif.); Grand Junction, May 17, 1892, *Eastwood* (R.Mt., Calif., Gray).

Utah: north of Duchesne, June 22, 1922, *Osterhout 6200* (R.Mt.); Theodore, May 14, 1908, *Jones* (Pomona).

The aggregate treated here as *C. nana* is distinguished chiefly by the short corollas and the uniformly muricate nutlets. These are characters possessed also by *C. cana* and *C. breviflora* but those species have conspicuously sericeous, minutely pustulate leaves, while in *C. nana* the leaves always have the two kinds of

trichomes and are either distinctly tomentulose or at least conspicuously pustulate.

In any general floristic work, the author would have no hesitation in submerging the varieties recognized here and would use only the specific name for the assemblage—so close are the varieties and so numerous the intermediates. They seem to be geographic units and so are worthy of discrimination in a more technical treatment.

33. C. cana (A. Nels.) new comb. Plate 29, figs. 92–94.

Oreocarya cana A. Nels. Bot. Gaz. **34:** 30. 1902.

Krynitzkia sericea Nutt., fide Rydb. Fl. Rocky Mountains, 723. 1917. This combination was neither published nor suggested by Nuttall since he never used the generic name *Krynitzkia.*

Very densely caespitose long-lived perennial; leaves narrowly oblanceolate, usually acute, clustered on the crowns of the caudices, 2–6 cm. long, densely and, to the naked eye, uniformly silky strigose, older leaves under the lens inconspicuously pustulate below and setose with setae that are scarcely differentiated from the strigose hairs, upper surface obscurely pustulate; inflorescence narrow, mainly restricted to the upper ½ of the stem, densely but rather weakly setose, foliar bracts inconspicuous; calyx rather finely setose, sepals in anthesis linear or linear-lanceolate, acute, 3 mm. long, in fruit 5.5–6 mm. long, exceeding the mature nutlets by 3–4 mm.; corolla white, tube about 3 mm. long, as long as the calyx lobes, crests at the base of the tube evident, fornices distinctly papillose, low, rounded, about 0.5 mm. high, probably yellow, limb about 6 mm. broad, tube and corolla lobes subequal, lobes united for about ¼ their length; fruit usually unsymmetrical, tending to be lance-ovoid, only one nutlet usually maturing, style shorter than the mature nutlet; nutlets lanceolate, acute, 3–3.5 mm. long, margins in contact (when more than one develops), acute or obtuse, surfaces of nutlets dull, the dorsal densely muricate with elongated and sometimes confluent papillae, the ventral surfaces similar but papillae less elevated, scar open toward the base, rather narrowly triangular, no elevated margin present.

Distribution: Upper Sonoran Zone, central to southeastern

Wyoming, northeastern Colorado, and western Nebraska. Type: gravelly open hilltops, Ft. Laramie, Wyoming, *A. Nelson 8309.*

Specimens examined:

Nebraska: Ft. Robinson, June 1, 1890, *Bates* (N.Y.); War Bonnet, June 24, 1890, *Williams* (N.Y.); McColligan Canyon, Deuel Co., June 26, 1891, *Rydberg 256* (U.S., N.Y.); Sidney, May 23, 1922, *Nelson* (R.Mt.).

Wyoming: Birds Eye, June 25, 1910, *Nelson 9367* (R.Mt.); Pine Bluffs, June 27, 1889, *Bodin* (Minn.); Pine Bluffs, May 14, 1897, *Nelson 2876* (R.Mt., Calif., Field); Uva, July 10, 1894, *Nelson 389* (R.Mt.); Ft. Laramie, June 29, 1901, *Nelson 8309* (R.Mt., TYPE, Gray); Platte Hills, *Nuttall* (Phila.).

Colorado: Pawnee Buttes, Weld Co., June 17, 1919, *Osterhout 5902* (R.Mt., U.S., Gray, Osterh.); Tuttle, May 16, 1909, *Cary 276* (U.S.):

This is a most distinct species by virtue of its densely caespitose habit, its silky strigose indument, and muricate nutlets. It has no near relatives with which it might be confused in the region where it grows.

34. C. propria (Nels. & Macbr.) new comb.

Plate 29, figs. 95–97.

Krynitzkia fulvocanescens var. *idahoensis* Jones, Contr. West. Bot. **13:** 6. 1910. (Type: *Jones* No. *6474*, near Weiser, Idaho, April 28, 1900.)

Oreocarya propria Nels. & Macbr. Bot. Gaz. **62:** 145. 1916.

Densely caespitose, long-lived perennial; stems few to many from the branched, woody caudex, 15–25 cm. high, rather slender, sparsely and weakly setose, caudex densely clothed with the leaf-bases of previous years; leaves clustered on the crowns of the caudex, spatulate, obtuse, 4–8 cm. long, dorsal surface finely strigose and abundantly appressed-setulose with short pustulate bristles, ventral surface densely and finely strigose with a few pustulate hairs, petioles ciliate near the base with long white hairs; inflorescence narrow, continuous or nearly so, confined to the upper ½ or ⅔ of the stem, densely but rather weakly setose, foliar bracts not conspicuous; calyx densely and weakly setose

and hirsute, sepals in anthesis linear or linear-lanceolate, 4–6 mm. long, acute, in fruit 8–10 mm. long, exceeding the nutlets by about 5 mm.; corolla white, tube 3.5–5 mm. long, tube and sepals subequal, crests at base of tube conspicuous, fornices nearly 1 mm. high, probably yellow, finely papillose, limb about 7 mm. broad, lobes and tube subequal or the tube slightly longer, lobes united for about ⅓ their length; fruit ovoid, four nutlets commonly maturing, style exceeding the mature nutlets 2–3 mm.; nutlets lanceolate, acute or nearly so, 3–4 mm. long, margins acute, surfaces of nutlets dull, the dorsal densely and sinuously rugulose with narrow but relatively high ridges, conspicuously muricate near the margins, the ventral surfaces densely but not uniformly muriculate, these elevations sometimes irregularly confluent, scar narrow but slightly open, extending from the base nearly to the apex, no elevated margin evident.

Distribution: clay hillsides in the Upper Sonoran Zone of western Idaho and adjacent Oregon. Type: Vale, Malheur County (Oregon), May 14, 1896, *J. B. Leiberg 2049*.

Specimens examined:

Idaho: 18 miles below Weiser, April 28, 1900, *Jones 6474* (Pomona, Mo.).

Oregon: Malheur Valley near Harper Ranch, June 8, 1896, *Leiberg 2223* (Calif., U.S., Gray, TYPE); Vale, Malheur Co., May 14, 1896, *Leiberg 2049* (Pomona, Calif., Field, U.S., Gray).

It is difficult to say to what species this plant is most nearly related. It would perhaps be most easily confused with *C. cana* or *C. breviflora* but those are plants far removed from it geographically, and *C. propria* may not be very closely related to either. *C. propria* must stand as a very distinct specific unit.

35. C. breviflora (Osterh.) new comb.

Oreocarya breviflora Osterhout, Univ. Wyo. Publ. Bot. **1**: 169. 1926.

Long-lived perennial from a woody root; stems rather slender, solitary or few, 15–25 cm. high, white-hairy at the base with long, straight, appressed trichomes, strigose upwards and hirsute near the inflorescence; leaves conspicuously clustered near the base, oblanceolate to spatulate, obtuse, 2.5–5 cm. long, uniformly

silky strigose, pustulate hairs scarcely distinguishable from the others and difficult of observation in dried material, pustules very numerous on dorsal surface, few and small on ventral surface; inflorescence rather narrow, nearly continuous, on upper ½–¾ of stem, foliar bracts small, inconspicuous, inflorescence setose-hispid with divaricate bristles that (sometimes at least) become yellowish in age; calyx setose, sepals in anthesis linear or nearly so, acute, 4–5 mm. long, in fruit 8–10 mm. long, exceeding the nutlets by about 4 mm.; corolla white, tube 3–4 mm. long, slightly shorter than the sepals, crests evident at the base of the tube, fornices small, rounded, nearly closing the throat, 1 mm. or less long, yellow, limb 7–9 mm. in diameter, limb and tube subequal, lobes united for about ⅓ their length; fruit ovoid, usually less than 4 nutlets maturing, style very slightly (0.5 mm.) exceeding the mature nutlets; nutlets lanceolate in outline, acute or obtuse, 4 mm. long, margins in contact, acute, apices somewhat spreading, surfaces of nutlets dull, the dorsal uniformly muriculate, the ventral similar, scar open, triangular, extending from the base to near the middle of the nutlet, margin not elevated.

Distribution: northeastern Utah, probably in the upper part of the Upper Sonoran Zone. Type: 6½ miles north of Jensen (Utah), *Osterhout 6414*.

Specimens examined:

Utah: 6½ miles north of Jensen, June 19, 1925, *Osterhout 6414* (R.Mt., TYPE, Osterh.); Uinta Mts., 1902, *Langille 113* (N.Y., U.S.); Ft. Duchesne, May 22, 1908, *Jones* (Pomona).

C. breviflora is evidently closely related to *C. fulvocanescens*. It differs from that species chiefly by the short corolla tube and the low fornices. The ranges of the two seem consistently separated.

36. C. fulvocanescens (Gray) new comb.

Eritrichium fulvocanescens Gray, Proc. Am. Acad. **10**: 61. 1875.

Krynitzkia fulvocanescens Gray, Proc. Am. Acad. **20**: 280. 1885.

Oreocarya fulvocanescens (Gray) Greene, Pittonia **1**: 58. 1887.

O. nitida Greene, Pl. Baker. **3**: 21. 1901. (Type: in dry stony ground at Deer Run, Colorado, 11 June, *C. F. Baker 95*.)

Perennial and caespitose from a woody root; stems few to

many from the root, rather slender, 12–25 cm. high, white-hairy at the base with long, straight-appressed trichomes, strigose and hirsute upwards; leaves conspicuously clustered near the base, oblanceolate to linear-oblanceolate, usually acute, 2–8 cm. long, uniformly silky strigose, pustulate hairs scarcely differentiated and difficult of observation in dried material, pustules numerous on dorsal surface, few and small on ventral surface; inflorescence rather narrow, nearly continuous, on upper ½ or ¾ of the stem, softly setose-silky at first, later becoming more hispid, bristles usually turning yellowish with age, foliar bracts small, inconspicuous; calyx weakly but densely setose, sepals in anthesis linear or nearly so, acute, 6–8 mm. long, in fruit about 12 mm. long, exceeding the nutlets by 6–8 mm.; corolla white, tube 9–11 mm. long, exceeding the sepals by 2–4 mm., crests lacking at the base of the tube, fornices conspicuous, yellow, elongated, over 1 mm. long, spreading, limb 7–9 mm. in diameter, about ⅓ as long as the tube, lobes united for ¼ their length or less; fruit ovoid, 1–2 nutlets only usually maturing, style exceeding the mature nutlets by 2–5 mm. (species conspicuously heterostyled); nutlets lanceolate in outline, acute or obtuse, 4 mm. long, margins in contact (when more than 1 nutlet matures), apices somewhat spreading, margins acute or nearly obtuse, surfaces of nutlets dull, the dorsal densely and uniformly muriculate, the ventral similar, scar short, nearly closed, extending from the base about ⅓ the distance to the apex, margins not elevated.

Distribution: Upper Sonoran Zone in southwestern Colorado, northeastern New Mexico, southeastern Utah, and northeastern Arizona. Type: near Santa Fe, New Mexico, *Fendler 632*.

Specimens examined:

Colorado: Grand Junction, June 11, 1920, *Osterhout 6003* (R.Mt., U.S., Gray, Osterh.); Deer Run, June 11, 1901, *Baker 95* (Pomona, R.Mt., Calif., Mo., U.S., Gray); Grand Junction, May 17, 1892, *Eastwood* (R.Mt., U.S., Gray); Westwater, May 6, 1891, *Jones* (Pomona); Naturita, May 4, 1914, *Payson 271* (R.Mt., Minn., Field, Gray, Colo.); Naturita, June 26, 1924, *Payson & Payson 3876* (R.Mt., Mo., Gray); Paradox, June 13, 1912, *Walker 85* (R.Mt., Pomona, Minn., Mo., U.S., Gray); Paradox, June 21, 1912, *Walker 156* (R.Mt., Minn., U.S., Gray).

New Mexico: Gallup, June 14, 1916, *Eastwood 5596* (U.S., Gray); Aztec, Aug. 1899, *Baker 561* (Pomona, R.Mt., Mo., U.S., Gray); Bloomfield, San Juan Co., 1892, *Waring 15* (Phila.); near Santa Fe, 1847, *Fendler 632* (Field, Phila., Mo., U.S., Gray, TYPE); hills at Santa Fe, May 13, 1897, *A. A. & E. G. Heller 3517* (Minn., Mo., U.S.).

Utah: Cisco, May 2, 1890, *Jones* (Pomona, R.Mt., Calif.).

Arizona: 18 miles north of Holbrook, May 21, 1901, *Hough 39* (U.S.); Holbrook, May 6, 1899, *Zuck* (U.S.).

This is a very distinct species characterized by the long corollas with the elongated fornices, the silky indument, and the nutlets that are densely and uniformly muriculate. It is most likely to be confused with *C. echinoides* and *C. breviflora.* From the former it differs in the muriculations of the nutlets which may be acute but are never truly setose; from the latter in the long corolla and elongated fornices.

37. **C. echinoides** (Jones) new comb.

Krynitzkia echinoides Jones, Proc. Calif. Acad. Sci. II. **5**: 709. 1895.

Oreocarya echinoides (Jones) Macbr. Contr. Gray Herb. **48**: 31. 1916, as to synonymy, not as to specimens cited.

Caespitose perennial very similar in general appearance to *C. fulvocanescens;* stems 12–20 cm. tall; leaves crowded at the base, oblanceolate to spatulate, usually acute, 3–6 cm. long, dorsal surface strigose and densely appressed-setose with numerous pustulate hairs, ventral surface densely strigose, setae and pustules nearly or quite lacking, petioles somewhat ciliate at the base; inflorescence extending over upper ¾ of the stem, narrow, continuous, fulvous-setose, foliar bracts inconspicuous, calyx densely setose with spreading or divaricate, yellowish (in age) hairs, sepals in anthesis about 5 mm. long, linear or nearly so, acute, in fruit about 10 mm. long, exceeding the nutlets by about 6 mm.; corolla white or cream-colored, tube 8–9 mm. long, exceeding the sepals by 1.5–3 mm., crests at base of tube sometimes evident, fornices conspicuous, probably yellow, elongated, erect or spreading, 1–1.5 mm. long, limb 7–9 mm. in diameter, lobes nearly half as long as the tube, united for ¼–⅓ their length;

fruit lance-ovoid, fewer than 4 nutlets maturing (usually 1 or 2?), style exceeding mature nutlets 4–6 mm.; nutlets lanceolate in outline, nearly acute, about 4 mm. long, margins acute, probably in contact, surfaces of nutlets not glossy, the dorsal densely and uniformly papillose, each papilla usually bearing a short seta from the apex, sometimes several setae from a single large papilla, median dorsal ridge often evident, ventral surface similar, scar narrow, often unsymmetrical, extending from the base to about the middle of the nutlet, margin not elevated.

Distribution: Upper Sonoran Zone in southern Utah and adjacent Arizona. Type: Pahria Canyon, Utah, 5300 ft. alt., in red sand, *M. E. Jones 5279p*.

Specimens examined:

Utah: Pahria Canyon, May 26, 1894, *Jones 5297p* (Pomona, TYPE); Cannonville, May 28, 1894, *Jones 5312 ac* (Pomona, Calif., U.S.).

Arizona: Navajo Spring, near Johnson City, June 19, 1890, *Jones* (Pomona).

C. echinoides was entirely misunderstood and misinterpreted by Macbride in Proc. Am. Acad. **51:** 547. 1916, and in Contr. Gray Herb. **48:** 31. 1916. From the specimens cited by Macbride it is evident that he never saw a specimen of true *echinoides* and his interpretation of the identity of the species was apparently obtained from Jones' discussion of the identity of *fulvocanescens*. With Jones' specimens at hand there can be no doubt as to the plant that should bear the name of *echinoides*. Two collections are cited by Jones as representing his new species, and these two are essentially identical. His description very clearly applies to the collections cited and so the plant with hedgehog-like nutlets from Pahria Canyon and from Cannonville must be taken as true *echinoides*. Jones took Watson's plant from Utah (*Eritrichium glomeratum* var. *fulvocanescens* Wats. Bot. King's Exp. 243. 1871) as being the plant that must bear the specific name *fulvocanescens*. The first legal publication of this name is this publication of Watson's, and the type of his variety is the Utah plant collected by Fremont rather than the Fendlerian collection designated by Gray in manuscript. Whatever the type of Watson's variety may be, it does not bear on the case in hand.

The first specific use of the name *fulvocanescens* is in connection with Fendler's plant from Santa Fe, and so that plant becomes the type of the species *fulvocanescens* of Gray. It is not surprising that Jones considered his plant from Pahria Canyon and Fendler's plant from Santa Fe as conspecific; the two are certainly very closely related.

Although available material of *echinoides* is somewhat scanty it seems that the flowers in this species are only slightly dimorphic. The difference between the point of attachment in stamens from flowers assumed to represent the two forms is not over 1.5 mm. In *C. fulvocanescens* the difference is distinctly greater.

38. **C. Jonesiana** (Payson) new comb. Plate 29, figs. 98–100.
Oreocarya Jonesiana Payson, Univ. Wyo. Publ. Bot. **1**: 168. 1926.

Densely caespitose perennial from a woody root; caudex much branched, the branches clothed with the remains of leaves of previous years; stems 6–8 cm. tall, rather slender, sparsely setose and coarsely strigose; basal leaves numerous, thick, spatulate to obovate-spatulate, 1.5–3.5 cm. long, obtuse, blade abruptly or gradually reduced to the slender petiole, cauline leaves few, spatulate, smaller, leaf surfaces appressed-setose and coarsely strigose, the petioles not ciliate, pustulate hairs present and conspicuous on both surfaces, somewhat more numerous on dorsal; inflorescence mostly confined to upper ½ of stem, narrow, cymules nearly sessile, foliar bracts inconspicuous, inflorescence densely and coarsely fulvous-setose; calyx densely setose, sepals in anthesis linear, acute, about 7 mm. long, in fruit about 10 mm. long, exceeding the nutlets 4–5 mm.; corolla probably white with yellow fornices, tube 13–15 mm. long, 6–8 mm. longer than the sepals, rather conspicuously flaring in the throat, crests at the base of the tube obsolete, fornices very broad and low, spreading, limb 10–12 mm. broad, lobes not over ⅓ as long as the tube, united for about ¼ their length; fruit lance-ovoid, apparently only 2–3 nutlets usually maturing, style exceeding the mature nutlets 4–5 mm. (species apparently only slightly heterostyled); nutlets lanceolate in outline, obtuse or acute, about 4 mm. long, margins in contact, acute, apices scarcely spreading, surfaces dull,

the dorsal muricate and sometimes distinctly rugose due to the confluence of the murications, slightly keeled, the elevations usually acute and often tipped with a distinct seta, ventral surface similar to the dorsal but elevations somewhat fewer and lower, scar narrow, straight, open, extending from the base $^4/_5$ of distance to apex, no elevated margin.

Distribution: Upper Sonoran Zone in south-central Utah. Type: San Rafael Swell, *Jones*.

Specimens examined:

Utah: San Rafael Swell, May 15, 1914, *Jones* (Pomona, TYPE); San Rafael Swell, May 19, 1914, *Jones* (Pomona).

This species seems most closely related to *C. fulvocanescens* and *C. echinoides* but is much more distinct from them than they are from one another. It differs from them by its more densely caespitose habit, lower stems, harsher pubescence, less conspicuously dimorphic flowers, lower and broader fornices, and slightly rugose nutlets.

Series 5. FLAVOCULATAE. Nutlets usually deeply and conspicuously rugose and tuberculate, sometimes muricate or foveolate also. Scar, except in *C. Bakeri*, at least slightly open and then showing a tendency to be constricted above the base, margin usually elevated. Species 39–46.

39. C. Wetherillii (Eastw.) new comb. Plate 30, figs. 101–103.

Krynitzkia glomerata var. *acuta* Jones, Zoe **2**: 250. 1891. (Type: "Collected May 2, 1890, at Cisco, Utah.")

Oreocarya Wetherillii Eastw. Bull. Torr. Bot. Club **30**: 242. 1903.

Short-lived perennial or biennial; stem stout, branched from the base with one stout stem and often with one or more low slender ones, 1.5–3 dm. high, densely strigose and conspicuously setose with long white divaricate bristles; radical leaves spatulate or oblanceolate, obtuse or acute, 1–3 cm. long, rather coarsely strigose dorsally and rather shortly setose with spreading but scarcely divaricate bristles, ventral surface more finely strigose, not setose, pustules abundant on dorsal surface, nearly or entirely absent on ventral (sometimes more abundant in age), petioles broad, scarcely ciliate; cauline leaves narrower, scarcely petioled,

usually acute, 1.5–5 cm. long; inflorescence on upper ¾ of the stem, rather broad and open, not interrupted, cymules elongating, setose, foliar bracts rather conspicuous below, diminishing upwards; calyx abundantly setose, sepals linear-lanceolate, acute, 5–6 mm. long in anthesis, in fruit about 1 cm. long, exceeding the mature nutlets by about 6 mm.; corolla white, tube 6–7 mm. long, exceeding the calyx lobes by about 2 mm., crests at the base of the tube absent or inconspicuous, fornices probably yellow, conspicuously long-papillose, emarginate, about 1 mm. long, limb 10–12 mm. broad, tube about twice as long as the lobes, lobes united for about ⅓ their length; fruit ovoid, 3–4 nutlets usually maturing, style exceeding the mature nutlets 3–4 mm.; nutlets rather broadly lanceolate, obtuse or subacute, about 4 mm. long, margins acute, in contact, surfaces of nutlets slightly glossy, dorsal with numerous conspicuous rounded tubercles that are at times somewhat confluent and so tend to form rugae, not muriculate, ventral surface similar but tubercles lower, some confluent, scar narrow but open, surrounded by a distinct elevated margin.

Distribution: Upper Sonoran Zone, east-central Utah. Type: "Collected by the author [*Eastwood*] in flower and fruit, May 25, 1892, in Court House Wash, near Moab, southeastern Utah."

Specimens examined:

Utah: Court House Wash, near Moab, May 25, 1892, *Eastwood* (Calif., part of TYPE); Cisco, May 2, 1891, *Jones* (Calif., Mo., U.S., Gray); Green River, May 7, 1891, *Jones* (R.Mt., Calif., Pomona); Price, 1900, *Stokes* (Calif.); Price, June 29, 1898, *Jones* (Pomona).

C. Wetherillii is most closely related to *C. longiflora*, and at one time the author felt that they could not be separated specifically. However, more careful study has seemed to show that they are definitely distinct. The differences between the two species may be contrasted as follows:

C. Wetherillii	*C. longiflora*
Radical leaves distinctly pustulate below, scarcely so above.	Pustulate hairs about equally distributed on both surfaces.
Species not known to have dimorphic flowers (this may be due to lack of specimens).	Species with evidently dimorphic flowers.

Fornices long-papillose or "hispid."	Fornices scarcely papillose at all.
Corolla tube 6–7 mm. long.	Corolla tube 12–14 mm. long.
Nutlets tuberculate and more or less rugose.	Nutlets distinctly rugose, scarcely tuberculate.
Scar open but narrow, slightly broader near the middle, surrounded by a distinct elevated margin.	Scar very narrow, sides nearly parallel, elevated margin not evident or very slight.

40. C. longiflora (A. Nels.) new comb. Plate 30, figs. 104–106.

Oreocarya longiflora A. Nels. Erythea **7**: 67. 1899.

O. horridula Greene, Pl. Baker. **3**: 20. 1901. (Type: Deer Run, Colorado, 11 June, on a dry bank, *C. F. Baker 133.*)

A short-lived perennial (possibly at times a biennial); stems several (1–5), unbranched, rather stout, 10–30 cm. tall, conspicuously setose with long, divaricate bristles, hirsute; leaves clustered near the base of the stem, oblanceolate, spatulate or nearly obovate, obtuse, 2.5–7 cm. long, blade narrowed to a broad, setose petiole, blade setose with ascending rather than strongly divaricate bristles, sparingly hirsute, some smaller contorted hairs also present on the surface, pustulate hairs about equally distributed on the two surfaces; inflorescence occupying ¾ or more of the stem, rather broad and loose, bracts not exceeding the flowers, whole inflorescence strikingly setose with long straight bristles; calyx strongly setose-hairy, sepals in anthesis linear-lanceolate to nearly linear, acute, 8–10 mm. long, in fruit 10–12 mm. long, erect, exceeding the nutlets by 7–10 mm.; corolla white, conspicuously dimorphic, tube 12–14 mm. long, usually exceeding the calyx lobes by 2–4 mm., crests at the base lacking, fornices not over 1 mm. long, yellow, broad, rounded, or emarginate, they and the upper part of the tube papillose, limb about 10 mm. in diameter, lobes ¼ to ⅓ as long as the tube, united about ¼ their length from throat; fruit ovoid, 2, 3 or 4 nutlets maturing (apparently usually less than 4), styles exceeding mature nutlets 3–6 mm.; nutlet margins nearly in contact, acute, surfaces of nutlets pale, somewhat glossy, the dorsal surface densely tuberculate and more or less rugose, tubercles and rugae usually rounded on the top, the

ventral surface similar, scar straight, closed or narrowly open, surrounded by a slightly elevated tuberculate margin.

Distribution: Upper Sonoran Zone in west-central Colorado and probably adjacent Utah. Type: "Collected by Prof. *C. S. Crandall*, at Palisades, Mesa Co., Colo., May 14, 1898."

Specimens examined:

Colorado: DeBeque, Mesa Co., May 19, 1911, *Osterhout 4463* (R.Mt.); Delta, May 20, 1911, *Osterhout 4497* (R.Mt.); DeBeque, June 9, 1920, *Osterhout 5975* (R.Mt., U.S., Gray); Grand Junction, May 14, 1892, *Eastwood* (Pomona, U.S., Gray); Palisades, Mesa Co., May 14, 1898, *Crandall* (R.Mt., TYPE); Westwater, May 6, 1891, *Jones* (Pomona); Montrose, May 23, 1912, *Payson 35* (R.Mt.); Montrose, June 14, 1914, *Payson 659* (R.Mt., Gray).

C. longiflora is perhaps most closely related to *C. Wetherillii* and is most likely to be confused with that species. For a comparison of these two species see the discussion under *C. Wetherillii.*

O. horridula Greene has not been seen except for a few fragments from the type. A comparison of mature nutlets with those of *C. longiflora* shows them to be most similar; a comparison of *longiflora* with the description of *horridula* reveals no important differences; the type locality of *horridula* at Deer Run makes it very probable that the two are identical.

41. C. tenuis (Eastw.) new comb. Plate 30, figs. 107–109.

Oreocarya tenuis Eastw. Bull. Torr. Bot. Club **30:** 244. 1903.

Perennial, more or less caespitose; stems several to many from the base, slender, 15–25 cm. high, strigose and divaricate-setose with rather short, weak bristles; leaves clustered at the base, rather few on the stem, linear-spatulate, obtuse or subacute, 2–4 cm. long, strigose and weakly appressed-setose on the dorsal surface, uniformly strigose on ventral surface, densely pustulate dorsally, sparsely, if at all, pustulate ventrally, petioles scarcely ciliate; inflorescence extending over upper ½ to ¾ of the stem, rather narrow, uninterrupted, rather weakly but abundantly setose, foliar bracts inconspicuous; calyx strigose and abundantly short-setose, sepals in anthesis narrowly lanceolate, acute, 4–5 mm. long, in fruit 6–7 mm. long, exceeding the nutlets by 3–4 mm.;

corolla white, tube 6 mm. long, slightly exceeding the sepals in anthesis (not over 1 mm.), crests at the base of the corolla tube present or absent, fornices probably yellow, broad, truncate, emarginate, about 0.5 mm. high, distinctly papillose, limb unusually campanulate for the genus, about 5 mm. across, tube 1.5–2 times as long as the limb, lobes united for about ⅓ their length, anthers with their apices about on a level with the tops of the fornices; fruit ovoid, 3–4 nutlets usually maturing (?), style exceeding the mature nutlets by about 4 mm.; nutlets lanceolate in outline, nearly acute, about 4 mm. long, margins in contact, acute, surfaces of nutlets dull, the dorsal sharply and deeply rugose, with an evident but sinuous or flexuous dorsal ridge, sparingly tuberculate, not at all muriculate, the ventral surface sharply rugose, scar narrow but evidently open, surrounded by an elevated margin. No evidence is at hand to show that this species is dimorphic in flower structure. With so few collections available, however, it is possible that they may all represent one form.

Distribution: Upper Sonoran Zone in southeastern Utah. Type: "near Moab, in Court House Wash, southeastern Utah, May 25, 1892," *Alice Eastwood.*

Specimens examined:

Utah: without locality, May–Oct. 1898, *Purpus* (Calif.); Court House Wash., s.e. Utah, May 25, 1892, *Eastwood* (R.Mt., Calif., Gray).

C. tenuis, although known from but two collections, possesses characters that seem to prove its right to specific recognition. These outstanding characteristics are (1) the corolla tube that slightly, but definitely, exceeds the calyx lobes, (2) the campanulate rather than spreading limb of the corolla, (3) the anthers whose apices are on a level with the fornices, (4) the sharply and deeply rugose nutlets, (5) the narrow leaves and slender erect stems. As is the case in most species of the section *Oreocarya*, it is difficult to say to what species it is most closely related. For one reason and another it seems nearest to *Osterhoutii* (from which it differs by the tall stems and longer corolla tube), to *longiflora* (from which it differs in the shorter corolla tube, sharply rugose nutlets, shorter setae), and to *Wetherillii* (from which it differs by the narrower leaves, sharply rugose nutlets, and much smaller flowers).

42. C. Osterhoutii (Payson) new comb. Plate 30, figs. 110–112.

Oreocarya Osterhoutii Payson, Univ. Wyo. Publ. Bot. **1**: 167. 1926.

Densely caespitose perennial; caudices much branched and clothed with the leaf-bases of previous years; stems slender, 2–6 cm. high, near the base covered with long, white, mostly appressed hairs, strigose and weakly setose upwards; leaves spatulate or oblanceolate, usually obtuse, 1–1.5 cm. long, strigose and appressed-setose on dorsal surface, almost uniformly strigose on ventral surface, pustulate hairs lacking on ventral surface, well developed on dorsal, petioles somewhat ciliate; inflorescence reduced but open, on upper ¾ of the stem, rather softly and shortly setose, foliar bracts inconspicuous; calyx strigose-hirsute and sparsely and weakly setose, sepals in anthesis linear-lanceolate, acute, 2–4 mm. long, in fruit 5–6 mm. long, exceeding the mature nutlets by 2–3 mm.; corolla white, tube about 3 mm. long, equalling the sepals in anthesis, crests at the base of the tube usually evident, poorly developed, fornices yellow, broad and low (0.5 mm. long), emarginate, distinctly papillose, limb 5–7 mm. broad, tube and limb subequal, lobes united for about ⅓ their length; fruit broadly ovoid, in the material examined only 1 or 2 nutlets have matured, style exceeding the mature nutlets by about 0.5 mm.; nutlets turgid, lanceolate in outline, acute, 3 mm. long, somewhat incurved margins usually not in contact, obtuse, surfaces of nutlets somewhat glossy, the dorsal indefinitely carinate, sharply tuberculate and somewhat rugose, the ventral tuberculate with fewer tubercles, scar open, extending at least ½ the length of the nutlet, evident, elevated and tuberculate margin present.

Distribution: Upper Sonoran Zone in western Colorado and eastern Utah. Type: Monument Park, near Grand Junction, Colorado, *Geo. E. Osterhout 6138*.

Specimens examined:

Colorado: Grand Junction, Monument Park, June 3, 1921, *Osterhout 6138* (R.Mt., TYPE, Colo., Osterh.).

Utah: Court House Wash, June 16, 1913, *Jones* (Pomona).

This species is one of the most densely caespitose members of the genus. For this reason and because of the short stems it

might be confused with *C. nana*. The resemblance, however, between the two species is quite superficial. It seems to be most closely related to *C. paradoxa*. The short corollas separate it definitely from that species.

43. **C. paradoxa** (A. Nels.) new comb. Plate 30, figs. 113–115.

Oreocarya paradoxa A. Nelson, Bot. Gaz. **56**: 69. 1913.

O. gypsophila Payson, Bot. Gaz. **60**: 380. 1915. (Type: "on a dry gypsum hill in Paradox Valley, Colorado, alt. slightly over 5000 ft., *Payson 458*, June 18, 1914.")

Densely caespitose perennial; caudices much branched and clothed with the leaf-bases of previous years; stems slender, 5–12 cm. high, somewhat white-hairy near the base, more or less strigose and weakly setose above; leaves crowded on the end of the branches of the caudex, spatulate or oblanceolate, usually folded, obtuse, 1.5–3 cm. long, strigose and appressed-setose on the dorsal surface, uniformly strigose on the ventral surface, pustulate hairs lacking on the ventral surface, well developed on the dorsal, petioles somewhat ciliate; inflorescence reduced but not congested, on upper ½–¾ of stem, hirsute or weakly setose, foliar bracts inconspicuous; calyx weakly setose with spreading hairs, sepals in anthesis linear-lanceolate, acute, 4–5 mm. long, in fruit 7–8 mm. long, exceeding the mature nutlets by about 5 mm.; corolla white, tube 10–12 mm. long, 2–3 times as long as the sepals, crests at base of tube lacking, fornices yellow, broad and low (0.5 mm. high), slightly emarginate, distinctly papillose, limb 10–12 mm. broad, tube about 2½ times as long as the lobes, lobes united for about ¼ their length; fruit oblate-ovoid, all 4 nutlets usually maturing, style exceeding the mature nutlets by 4–8 mm. (species conspicuously heterostyled); nutlets lanceolate in outline, acute or obtuse, turgid, 2–3 mm. long, not incurved, margins not in contact, obtuse, surfaces of nutlets slightly glossy, dorsal surface not carinate, densely tuberculate and rugose, definitely margined, the ventral tuberculate, scar open, extending at least ½ the length of the nutlet, margin slightly elevated.

Distribution: Upper Sonoran Zone, western Colorado, and eastern Utah. Type: on dry "gyp" hills, in Paradox Valley, Colorado, *E. P. Walker 91*.

Specimens examined:

Colorado: Paradox, Montrose Co., June 17, 1912, *Walker 91* (R.Mt., TYPE, Pomona, Minn., Mo., U.S., Gray); East Paradox Valley, June 20, 1924, *Payson & Payson 4223* (R.Mt., Mo., Gray); Paradox Valley, June 18, 1914, *Payson 458* (R.Mt., Mo., Gray).

Utah: Myton, May 20, 1908, *Jones* (Pomona).

This species is conspicuously dimorphic in flower structure. The stamens in the two forms are attached 4–5 mm. apart and the styles differ in length by about the same amount. In the original description of *paradoxa* the anthers are described as being "just below the crests." On the type sheet in the Rocky Mountain Herbarium, three plants are fastened; on two of these the anthers are as described, on the third plant they are attached about half way up the tube. In the original description of *gypsophila* the anthers are said to be "attached about midway on the corolla tube." All the specimens preserved on the type sheet in the Rocky Mountain Herbarium have anthers attached just below the fornices. This is to be explained by supposing that the specimens from which the description was drawn were distributed and other plants were kept to represent the type and at the time these two specific names were proposed neither Dr. Nelson nor the writer suspected the dimorphic nature of the flowers. Due to the fact that the flowers had discolored somewhat in fading, Dr. Nelson described them as yellow. The author knew his plant to have white flowers. Unfortunately the specimens of *paradoxa* had not yet been mounted and so were not available when *gypsophila* was described. However, there can be no doubt but that the two names are completely synonymous.

C. paradoxa is unique in the possession of a long corolla tube, densely caespitose habit, and conspicuously rugose and tuberculate nutlets that are not in contact on the margins. Its nearest relative is perhaps *C. Osterhoutii*. That species may be distinguished at once by the short corollas.

44. C. Bakeri (Greene) new comb. Plate 30, figs. 116–118.

Oreocarya Bakeri Greene, Pittonia 4: 92. 1899.

O. eulophus Rydb. Bull. Torr. Bot. Club 31: 637. 1904. (Type: Dolores, Colorado, 1892, *Crandall.*)

Evidently perennial, probably short-lived, from a stout root; caudex with few to several rather short branches; stems 1–8 (rarely more), rather slender, 12–30 cm. high, densely setose with horizontal bristles, hirsute; leaves somewhat clustered at the base, oblanceolate, blade narrowed to a distinct, setose petiole, obtuse, 4–8 cm. long, dorsal surface appressed and rather finely setose with numerous pustulate hairs and coarsely strigose, ventral surface densely strigose and with a few inconspicuous, appressed, pustulate setae; inflorescence occupying upper $^4/_5$, or more, of stem, somewhat glomerate, foliar bracts few, linear-oblanceolate, exceeding the cymules, often reflexed; calyx setose and hirsute, sepals in anthesis lanceolate-acuminate, about 6 mm. long, in fruit ovate-lanceolate, shortly acuminate, about 9 mm. long, exceeding mature nutlets 4–5 mm.; corolla white, tube 6–7 mm. long, usually very slightly longer than the sepals in anthesis, crests at base of tube evident, fornices yellow, conspicuous, linear, emarginate, about 2 mm. long, papillose, limb 7–8 mm. broad, nearly twice as long as the radius of the limb, united portion ½ as long as the lobes or less; fruit broadly ovoid, 2–3 or (usually) 4 nutlets maturing, style 1–2 mm. longer than nutlets; nutlets ovate-lanceolate in outline, obtuse, turgid, 3–3.5 mm. long, margins not closely in contact, obtuse, surfaces of nutlets rather dull, the dorsal densely and irregularly rugose and tuberculate, sometimes more or less foveolate, rugae and tubercles usually acute, ventral surface mainly tuberculate, scar, in dried nutlets, usually curved or twisted, closed, surrounded by an elevated, tuberculate margin.

Distribution: Transition or higher Upper Sonoran Zone in southwestern Colorado and southeastern Utah. Type: "Collected on the Mancos River sage plains in southern Colorado, by Messrs. *Baker, Earle & Tracy*, 8 July, 1898, and distributed under No. *827*."

Specimens examined:

Colorado: Meeker, June 8, 1902, *Osterhout 2610* (Osterh.); Gunnison, July, 1897, *Bethel* (Colo.); Gunnison Co., June, 1888, *Eastwood* (U.S.); 3 miles south of Ridgway, July 16, 1917, *Payson 1079* (R.Mt., Mo., Gray); Ridgway, June 18, 1924, *Payson & Payson 3834* (R.Mt., Mo., Gray); Dolores, June 16, 1892,

Crandall (N.Y.); Dolores, June 15, 1892, *Herb. Colo. Agric. Coll.* (N.Y.); Mancos, Aug. 11, 1925, *Smith 3936* (R.Mt.); sage plains, Mancos, July 8, 1898, *Baker, Earle & Tracy 827* (Pomona); Mesa Verde, Aug. 2, 1917, *Payson 1135* (R.Mt.); Chimney Rock Mesa, Piedra, June 24, 1924, *Schmoll 1281* (R.Mt., Colo.); Chimney Rock Mesa, Piedra, June 30, 1924, *Schmoll 1346* (R.Mt., Colo.).

Utah: meadow south of Monticello, 1911, *Rydberg & Garrett 9130* (N.Y.).

So far as the material at hand shows, the flowers of this species have only one form. They have the anthers fastened about half way up the tube and the stigma reaches at least to the base of the anthers and possibly higher. The very low position of the anthers makes it seem probable that another form with anthers near the top of the tube will be found. The position of the stigma, however, is that which usually occurs in the species with only one kind of flower.

This species is a very distinct one characterized by the leaves that lack pustulate hairs above, the corolla tube that slightly exceeds the sepals, and the nutlets with a closed scar and an elevated margin.

45. **C. mensana** (Jones) new comb. Plate 30, figs. 119–121.

Krynitzkia mensana Jones, Contr. West. Bot. **13**: 4. 1910.

Oreocarya mensana (Jones) Payson, Univ. Wyo. Publ. Bot. **1**: 171. 1926.

Rather loosely caespitose perennial; stems several from the base, 8–12 cm. high, sparsely strigose and abundantly white-setose with rather slender bristles; leaves rather broadly spatulate to oblanceolate, 2–7 cm. long, obtuse, lower surface rather sparsely strigose, setose with spreading, slender bristles that are pustulate at the base, upper surface more finely strigose, setae inconspicuous, pustules fewer; inflorescence not greatly exceeding the radical leaves, somewhat open and paniculate, extending over $^3/_4$–$^4/_5$ of the stem, foliar bracts large and well-developed; calyx strigose and conspicuously setose, sepals in anthesis linear-lanceolate, acute, about 4 mm. long, in fruit 7–8 mm. long, exceeding the nutlets by 4–5 mm.; corolla white, tube about 4 mm.

long, equalling or shorter than the sepals in anthesis, crests at the base of the tube nearly but not quite obsolete, fornices probably yellow, less than 1 mm. long, slightly papillose, limb 6–8 mm. broad, lobes united for about ⅓ their length, nearly or quite as long as the tube; fruit very broadly ovoid, 2–4 nutlets maturing (in the material examined), style exceeding the nutlets 1.5–2 mm.; nutlets lanceolate, obtuse, 3–3.5 mm. long, margins usually obtuse, definitely separated by an interval in the material examined, surfaces of nutlets dull or somewhat glossy, the dorsal conspicuously but rather openly muricate, tuberculate and rugose, somewhat ridged down the median line, not foveolate, the ventral surface conspicuously tuberculate, scarcely muricate or rugose, scar open and very conspicuous, surrounded by a high elevated margin.

Distribution: Upper Sonoran Zone in south-central Utah. Type: Emery, May 16, 1894, *M. E. Jones 5445p.*

Specimens examined:

Utah: Emery, June 16, 1894, *Jones 5445p* (Pomona, TYPE, U.S.); San Rafael Swell, May 15, 1914, *Jones* (Pomona).

C. mensana is certainly most closely related to *C. flavoculata* but is probably well worthy of specific rank. The short corolla tubes serve to distinguish it definitely from that species. In addition it is of characteristic habit due to the short stems.

46. C. flavoculata (A. Nels.) new comb. Plate 30, figs. 122–124.

Oreocarya flavoculata A. Nels. Erythea **7**: 66. 1899.

O. flavoculata spatulata A. Nels. Erythea **7**: 67. 1899. (Type: from gravelly hill tops near Evanston, Wyoming, *Nelson 2977*, May 29, 1897.)

O. cristata Eastw. Bull. Torr. Bot. Club **30**: 244. 1903. (Type: Grand Junction, Colo., May 17, 1892, *Eastwood.*)

O. Shockleyi Eastw. Bull. Torr. Bot. Club **30**: 245. 1903. (Type: Miller Mountain, Esmeralda Co., Nevada, elev. 7500 ft., *Shockley 244.*)

O. Eastwoodae Nels. & Kennedy, Muhlenbergia **3**: 141. 1908. (Type: Mormon Mts., Lincoln Co., Nevada, *P. B. Kennedy & L. N. Goodding 146.*)

Caespitose perennial from a woody root; stems few to many

from the base, rather slender, 10–30 cm. high, strigose and densely setose with rather slender bristles; leaves linear-oblanceolate to spatulate, usually obtuse but sometimes acute, 3–8 cm. long, densely strigose and, usually, rather weakly setose, abundantly pustulate on dorsal surface, ventral surface sometimes silky-strigose and quite lacking in pustulate setae, sometimes as densely pustulate as on the dorsal surface; inflorescence continuous or somewhat interrupted, rather narrow, usually extending over upper ½ or ⅔ of the stem, densely but rather weakly and softly setose, foliar bracts not conspicuous; calyx densely setose and strigose, sepals in anthesis linear-lanceolate, acute, about 5 mm. long, in fruit lanceolate or broader, acuminate, often spreading in age, 8–10 mm. long, exceeding the nutlets 5–7 mm.; corolla white or pale yellow, tube 7–10 mm. long, exceeding the sepals in anthesis by 1.5–3 mm., crests at the base of the tube lacking, fornices conspicuously yellow, rather narrow, long (about 1.5 mm.), slightly papillose, limb 8–12 mm. broad, lobes united for about ⅓ their length, ½ to ⅔ as long as the tube; fruit very broadly ovoid, all four nutlets commonly maturing, style exceeding the nutlets 4–8 mm. (species moderately heterostyled); nutlets lanceolate to ovate, mostly obtuse, 2.5–3.5 mm. long, margins usually obtuse, in contact or separated by a definite interval; surfaces of nutlets somewhat glossy, the dorsal muriculate, tuberculate and usually more or less rugose, sometimes almost foveolate, the ventral surface conspicuously tuberculate, scarcely muriculate, rarely rugose, scar open and very conspicuous, surrounded by a high elevated margin.

Distribution: Upper Sonoran and Transition Zones, Wyoming, western Colorado, Utah, Nevada, except the northern third, and southeastern California. Type: Piedmont, Wyoming, June 7, 1898, *A. Nelson 4572.*

Specimens examined:

Wyoming: Trapper Canyon, Big Horn Co., April 20, 1926, *Finley 2* (R.Mt.); Cummins, Albany Co., July 29, 1895, *Nelson 1511* (Mo.); Cooper Creek, June 6, 1898, *E. Nelson 4337* (R.Mt., Mo., U.S., Gray); hills of the Platte in the Rocky Mountains, *Nuttall* (Phila.); Cooper Creek, Albany Co., June 18, 1892, *Buffum 642* (R.Mt.); Hanna, Carbon Co., June 17, 1920, *Payson*

& Payson 1689 (R.Mt., Mo., Gray); Ft. Steele, June 18, 1898, *Nelson 4815* (R.Mt., Mo., U.S.); Ft. Steele, May 25–June 10, 1901, *Tweedy 4259* (U.S.); Point of Rocks, June 17, 1901, *Merrill & Wilcox 457* (R.Mt., U.S., Gray); Point of Rocks, June 15, 1898, *Nelson 4750* (R.Mt.); Steamboat Mt., June 9, 1900, *Nelson 7090* (R.Mt., Pomona, Minn., Mo., U.S., Gray); plains between Eden and Big Piney, July 6, 1922, *Payson & Payson 2583* (R.Mt., Mo.); Green River, June 23, 1896, *Jones 6726* (Pomona); between Evanston and Rock Springs, June 28, 1922, *Osterhout 6252* (R.Mt.); Granger, June 13, 1898, *Nelson 4749a* (R.Mt.); Kemmerer, June 1, 1907, *Nelson 9028* (R.Mt., Minn., Mo., Gray); Cokeville, June 11, 1898, *Nelson 4665* (R.Mt.); Carter, June 9, 1898, *Nelson 4616* (R.Mt.); Piedmont, June 7, 1898, *Nelson 4572* (R.Mt., TYPE, Field); Ft. Bridger, 1873, *Parry 49* (Gray); Evanston, June 4, 1898, *Nelson 4513* (R.Mt., U.S., Gray).

Colorado: south of Yampa River, Moffat Co., June 21, 1922, *Osterhout 6194* (R.Mt.); McCoys, Eagle Co., June 14, 1903, *Osterhout 2850* (R.Mt., Osterh.); Glenwood Springs, June 8, 1920, *Osterhout 5956* (R.Mt., U.S., Gray, Osterh.); Glenwood Springs, June 23, 1912, *Osterhout 4696* (R.Mt., Osterh.); Atchee, May 27, 1908, *Jones* (Pomona); Mack, May 27, 1908, *Jones* (Pomona); Grand Junction, June 11, 1920, *Osterhout 6006* (R.Mt., U.S., Gray, Osterh.); Westwater, May 6, 1891, *Jones 6715* (Pomona); Grand Junction, May 17, 1892, *Eastwood* (Calif.); Naturita, June 20, 1924, *Payson & Payson 3865* (R.Mt., Mo., Gray); 10 miles northeast of Nucla, Montrose Co., June 22, 1924, *Payson & Payson 3874, 3875* (R.Mt., Mo., Gray); near mouth of Tabeguache Creek, Montrose Co., June 6, 1917, *Payson 997* (R.Mt.); Naturita, April 22, 1914, *Payson 246* (R.Mt., Minn., Field, Mo., Gray); east of Montrose, June 15, 1915, *Payson 670* (R.Mt., Gray); near Montrose, July 10, 1917, *Payson 1046* (R.Mt.,); Naturita, May 22, 1914, *Payson 337* (R.Mt., Minn., Field, Mo., Gray, Colo.).

Utah: Uinta Mts., July, 1869, *Watson 852* (Gray); Brush Creek Canyon, Uinta Mts., July 7, 1902, *Goodding 1282* (R.Mt., Gray); low hills east of Bear Lake, June 16, 1922, *Gilbert* (R.Mt.); north of Duchesne, June 22, 1922, *Osterhout 6197* (R.Mt.); Theodore, May 12, 1908, *Jones* (Pomona); Robinson, June 26,

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Nevada: Sprucemont, July 21, 1891, *Jones 6715* (Pomona); Aurum, June 20, 1893, *Jones* (Pomona, Mo.); Aurum, July 5, 1905, *Jones* (Pomona); Furber, June 9, 1891, *Jones 6717* (Pomona); Ferguson Spring, June 14, 1900, *Jones* (Pomona); Osceola, June 26, 1906, *Jones* (Pomona); between Austin and Big Creek ranch, Lander Co., July 26, 1913, *Kennedy 4519* (Mo., Phila.); between Austin and Carter's ranch, July 27, 1913, *Hitchcock 755* (U.S.); Mormon Mts., Lincoln Co., July, 1906, *Kennedy & Goodding 146* (R.Mt., Mo., U.S.); east of Carson Lake, June 4, Lieut. Bryan's Exp. (Mo.); White Mts., near Sunland, Mineral Co., June 25, 1912, *Heller 10508* (Mo., U.S., Gray); Miller Mt., Esmeralda Co., 7500 ft., May & June, *Shockley 244* (Calif.); rocky soil, Palmetto Range, May–Oct. 1898, *Purpus 5869* (Calif., U.S.); Kyle Canyon, Charleston Mts., May 25, 1919, *Tidestrom 9610* (Mo.).

California: Summit, Owen's Valley, May 22, 1897, *Jones 6729* (Pomona, U.S.); Inyo Mts., June 25, 1891, *Coville & Funston 2151* (U.S.).

This species certainly possesses a number of different forms but so far they have seemed unworthy of named segregation from the main specific complex. Further study may develop some characters that will serve for varietal distinctions but at present these have not been found.

In western Colorado, near Naturita, the author is familiar with two forms, on a basis of setose-hispid and silky-strigose

indument. For a limited locality it would seem that these two forms are even worthy of specific rank but on examination of a large series of specimens it appears that the differentiation is only local. *Oreocarya cristata* Eastwood has very narrow leaves and so has a slightly different aspect. Osterhout's *6006* seems to be a good match for the type of *cristata*. *O. Shockleyi* is also characterized by narrow, acute leaves. In general appearance the collection from the Mormon Mts. by Kennedy and Goodding is very similar to the type collection of *O. Shockleyi*, nor can the author see that the nutlets are different.

The difference between the stamen insertion in the two forms of the flowers is probably never more than 3 mm. and is usually less than that.

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— (7) *C. leucophaea.*
Drummond, Thomas.
— (29) *C. Macounii.*
Eastwood, Alice.
8366 (1a) *C. Jamesii* var. *multicaulis;* — (1d) *C. Jamesii* var. *disticha;* — (1e) *C. Jamesii* var. *typica;* — (6) *C. flava;* — (21) *C. elata;* — (23) *C. aperta;* — (32d) *C. nana* var. *typica; 5596*, — (36) *C. fulvocanescens;* — (39) *C. Wetherillii;* — (40) *C. longiflora;* — (41) *C. tenuis;* — (44) *C. Bakeri;* — (46) *C. flavoculata.*
Eggert, H.
— (1a) *C. Jamesii* var. *multicaulis;* — (3) *C. Palmeri.*
Eggleston, W. W.
16184 (1a) *C. Jamesii* var. *multicaulis; 11194a, 15168* (1e) *C. Jamesii* var. *typica; 15379* (20) *C. thyrsiflora; 7838, 7959, 12520* (31) *C. Bradburiana; 11132* (32b) *C. nana* var. *Shantzii; 11118* (46) *C. flavoculata.*

Ellis, Charlotte C.
366, 463 (1a) *C. Jamesii* var. *multicaulis.*
Elmer, A. D. E.
1056 (7) *C. leucophaea.*
Engelmann, G.
— (10) *C. nubigena;* — (20) *C. thyrsiflora.*
Engelmann, H
— (20) *C. thyrsiflora;*— (22) *C. sericea.*
Evermann, B. W.
— (20) *C. thyrsiflora.*
Fendler, A.
636 (1a) *C. Jamesii* var. *multicaulis; 632* (36) *C. fulvocanescens.*
Ferris, R. & R. Duthie.
734 (10) *C. nubigena.*
Finley, C.
2 (46) *C. flavoculata.*
Flodman, J. H.
748 (30) *C. sobolifera.*
Forwood, W. H.
272, — (31) *C. Bradburiana;*
Garrett, A. O.
266, 1737 (32b) *C. nana* var. *Shantzii.*
Geyer, C. A.
— (31) *C. Bradburiana.*
Gilbert, H.
— (46) *C. flavoculata.*
Goldman, E. A.
407 (1a) *C. Jamesii* var. *multicaulis.*
Goodding, L. N.
1264, 2349 (1a) *C. Jamesii* var. *multicaulis; 208* (1e) *C. Jamesii* var. *typica; 814, 2221* (5) *C. confertiflora; 53,164* (6) *C. flava; 589* (12) *C. setosissima; 2286* (14) *C. insolita; 830* (15) *C. virginensis; 996* (17) *C. modesta; 60* (19) *C. caespitosa; 2076* (20) *C. thyrsiflora; 29, 230, 287* (31) *C. Bradburiana; 1074* (32a) *C. nana* var. *commixta; 1282* (46) *C. flavoculata.*
Greene, E. L.
32 (1a) *C. Jamesii* var. *multicaulis;* — (1c) *C. Jamesii* var. *cinerea; 300* (1e) *C. Jamesii* var. *typica;* — (12) *C. setosissima;*—(18) *C. humilis.*
Griffiths, David.
4268, 4912 (1a) *C. Jamesii* var. *multicaulis; 5300* (12) *C. setosissima.*
Griffiths, David & B. Hunter.
170 (27) *C. celosioides.*
Hall, H. M. & H. D. Babcock.
5270 (5) *C. confertiflora.*
Hall, H. M. & H. P. Chandler.
7234 (5) *C. confertiflora.*
Hanson, H. E.
A 140 (1a) *C. Jamesii* var. *multicaulis; 399* (4) *C. oblata.*
Havard, V.
— (1a) *C. Jamesii* var. *multicaulis;* — (1b) *C. Jamesii* var. *laxa;* — (4) *C. oblata;* — (31) *C. Bradburiana.*
Hayden, F. V.
— (19) *C. caespitosa;* — (28) *C. Sheldonii.*
Heller, A. A.
11016 (1f) *C. Jamesii* var. *abortiva; 8211, 9619* (5) *C. confertiflora; 13435* (10) *C. nubigena;* — (18) *C. humilis; 9185* (25) *C. interrupta; 10508* (46) *C. flavoculata.*
Heller, A. A. & E. G.
3577 (1c) *C. Jamesii* var. *cinerea; 3731* (20) *C. thyrsiflora; 3517* (36) *C. fulvocanescens.*
Henderson, L. F.
5212 (27) *C. celosioides; 2563* (28) *C. Sheldonii.*
Hess, W. L.
106 (1e) *C. Jamesii* var. *typica.*
Hicks, Mr. & Mrs. G. H.
178 (1c) *C. Jamesii* var. *cinerea.*
Hill, G. R., Jr.
— (32b) *C. nana* var. *Shantzii.*
Hindshaw, H. H.
2 (7) *C. leucophaea.*
Hitchcock, A. E.
1193 (1c) *C. Jamesii* var. *cinerea; 7* (6) *C. flava; 929, 1005* (25) *C. interrupta; 755* (46) *C. flavoculata.*
Hitchcock, A. S.
347 (1e) *C. Jamesii* var. *typica.*
Holzinger, G. A.
6 (31) *C. Bradburiana.*
Hough, W.
8 (1c) *C. Jamesii* var. *cinerea; 88* (12) *C. setosissima; 39* (36) *C. fulvocanescens.*

Howell, Thos.
431, — (27) *C. celosioides.*
Jaeger, E. C.
— (1a) *C. Jamesii* var. *multicaulis; 1113* (15) *C. virginensis.*
James, Edwin.
— (1e) *C. Jamesii* var. *typica.*
Johnston, E. L.
845 (1e) *C. Jamesii* var. *typica.*
Johnston, I. M.
2809 (1e) *C. Jamesii* var. *typica; 2818* (13) *C. virgata; 2817* (20) *C. thyrsiflora.*
Jones, B. J.
— (31) *C. Bradburiana.*
Jones, M. E.
4007, 4047, 5297q, 5298b, 5300, 6685, 6687, — (1a) *C. Jamesii* var. *multicaulis; 4042, 5328, 6684, 6688*, — (1c) *C. Jamesii* var. *cinerea; 66*, — (1e) *C. Jamesii* var. *typica; 5315f*, — (1f) *C. Jamesii* var. *abortiva; 3759* (4) *C. oblata; 5144, 5261j, 5289t*, — (5) *C. confertiflora; 5455c, 5464, 6725*, — (6) *C. flava; 5695al, 5790m, 5812, 6015al, 6054s, 6686* (12) *C. setosissima; 296*, — (13) *C. virgata;* — (14) *C. insolita; 5125, 5195a, 6728*, — (15) *C. virginensis; 6692, 6713* (17) *C. modesta; 6732*, — (18) *C. humilis; 6726* (19) *C. caespitosa; 972* (20) *C. thyrsiflora; 5607a* (22a) *C. sericea* var. *typica;* — (22b) *C. sericea* var. *perennis;* — (24) *C. rugulosa; 6673* (26) *C. spiculifera;* — (28) *C. Sheldonii;* — (29) *C. Macounii;* — (30) *C. sobolifera; 6698, 6699, 6700, 6705, 6706*, — (32a) *C. nana* var. *commixta; 1692, 6709, 6719*, — (32b) *C. nana* var. *Shantzii;* — (32c) *C. nana* var. *ovina;* — (32d) *C. nana* var. *typica; 6474* (34) *C. propria;* — (35) *C. breviflora;* — (36) *C. fulvocanescens; 5297p, 5312ac*, — (37) *C. echinoides;* — (38) *C. Jonesiana;* — (39) *C. Wetherillii;* — (40) *C. longiflora;* — (42) *C. Osterhoutii;* — (43) *C. paradoxa; 5445p*, — (45) *C. mensana; 5204l, 6677, 6678, 6715, 6716, 6717, 6720, 6721, 6726, 2729*, — (46) *C. flavoculata.*

Jones, W. W.
339 (1a) *C. Jamesii* var. *multicaulis.*
Kearney, T. H. & H. L. Shantz.
3098 (32b) *C. nana* var. *Shantzii.*
Kellerman, W. A.
6 (1e) *C. Jamesii* var. *typica.*
Kellogg, A.
— (18) *C. humilis.*
Kelsey, F. D.
102, — (29) *C. Macounii.*
Kennedy, P. B.
1664 (18) *C. humilis; 4519* (46) *C. flavoculata.*
Kennedy, P. B. & L. N. Goodding.
110 (5) *C. confertiflora; 78* (15) *C. virginensis; 146* (46) *C. flavoculata.*
Kirkwood, J. E.
1262 (28) *C. Sheldonii.*
Kirtley, C. L.
— (8) *C. salmonensis.*
Knowlton, F. H.
35 (20) *C. thyrsiflora.*
Kunze, R. E.
— (12) *C. setosissima.*
Langille, H. D.
117 (6) *C. flava; 113* (35) *C. breviflora.*
Lawrence, Wm. E.
1030 (27) *C. celosioides.*
Lechiner, H. J.
3 (7) *C. leucophaea.*
Leckenby, A. B.
— (7) *C. leucophaea.*
Leiberg, J. B.
5545 (1a) *C. Jamesii* var. *multicaulis; 5748* (12) *C. setosissma; 5294* (18) *C. humilis; 125* (27) *C. celosioides; 2049, 2223* (34) *C. propria.*
Lemmon, J. G.
165 (18) *C. humilis.*
Lemmon, J. G. & wife.
— (1a) *C. Jamesii* var. *multicaulis;* — (12) *C. setosissima.*
Letterman, G. W.
— (20) *C. thyrsiflora.*
Little, E. E. & E. M. Stanton.
179 (22a) *C. sericea* var. *typica.*
Lunell, J.
— (31) *C. Bradburiana.*

Lyall, David.
— (7) *C. leucophaea.*
Macbride, J. F.
93, 875 (26) *C. spiculifera; 2* (32b) *C. nana* var. *Shantzii.*
Macbride, J. F. & E. B. Payson.
950 (1c) *C. Jamesii* var. *cinerea; 705* (6) *C. flava; 3348* (8) *C. salmonensis; 3771* (10) *C. nubigena; 3039, 3223* (26) *C. spiculifera.*
MacDougal, D. T.
49 (1a) *C. Jamesii* var. *multicaulis; 204* (1c) *C. Jamesii* var. *cinerea; 79* (1e) *C. Jamesii* var. *typica; 165* (12) *C. setosissima; 169* (28) *C. Sheldonii; 60* (31) *C. Bradburiana.*
Macoun, John.
5801, 11819, 11820, 12800, 17087, 17089, 76741, 78500, 85007, — (29) *C. Macounii; 5802* (31) *C. Bradburiana.*
Mearns, E. A.
111, 359, 360, 2091, 2522 (1a) *C. Jamesii* var. *multicaulis.*
Merrill, E. D. & E. N. Wilcox.
486, 497, 726 (6) *C. flava; 617* (19) *C. caespitosa; 457* (46) *C. flavoculata.*
Metcalfe, O. B.
70, 431, 863, 1061 (1a) *C. Jamesii* var. *multicaulis; 1576* (4) *C. oblata.*
Moodie, M. E.
— (29) *C. Macounii.*
Moore, E. J.
— (31) *C. Bradburiana.*
Moyer, L. R.
453, — (31) *C. Bradburiana.*
Mulford, A. I.
— (32b) *C. nana* var. *Shantzii.*
Munz, P. A.
5721 (1f) *C. Jamesii* var. *abortiva.*
Munz, P. A., I. M. Johnston & R. D. Harwood.
4209 (16) *C. tumulosa.*
Nealley, G. C.
— (1a) *C. Jamesii* var. *multicaulis; 167* (4) *C. oblata.*
Nelson, A.
477, 2567, 2882, 8305, 9379, — (1e) *C. Jamesii* var. *typica; 22, 3074, 3098, 4771, 7067, 10693,* — (6) *C. flava; 231, 1267, 1937, 7338* (13) *C. virgata; 3072, 3120, 4671, 4749, 4772, 7078, 7255, 10696* (19) *C. caespitosa; 3035, 4715* (22b) *C. sericea* var. *perennis; 418, 1362, 1990, 7306, 8263* (20) *C. thyrsiflora; 255, 388, 1956, 4788, 4837, 6961, 7248, 8319, 9045, 9355, 9411, 9045, 10700, 10741,* — (31) *C. Bradburiana; 389, 2876, 8309, 9367,* — (33) *C. cana; 1511, 4513, 4572, 4616, 4665, 4749a, 4750, 4815, 7090, 9028,* (46) *C. flavoculata.*
Nelson, A. & J. F. Macbride.
1960, 1980, — (18) *C. humilis; 1799* (26) *C. spiculifera.*
Nelson, A. & E. Nelson.
5429 (28) *C. Sheldonii.*
Nelson, E. W.
6350 (1b) *C. Jamesii* var. *laxa.*
Nelson, E.
4906 (1e) *C. Jamesii* var. *typica; 4397* (6) *C. flava; 4338, 4497* (19) *C. caespitosa; 4337* (46) *C. flavoculata.*
Nicollet, I. N.
374 (31) *C. Bradburiana.*
Nuttall, T.
— (6) *C. flava;* — (19) *C. caespitosa;* — (20) *C. thyrsiflora;* — (33) *C. cana;* — (46) *C. flavoculata.*
Osterhout, G. E.
628, 2087 (1c) *C. Jamesii* var. *cinerea; 627, 629, 3992, 4979, 5754,* — (1e) *C. Jamesii* var. *typica; 6389, 6406* (6) *C. flava; 6195* (9) *C. stricta; 2463,* — (13) *C. virgata; 6248* (19) *C. caespitosa;* —, *4979, 5934* (20) *C. thyrsiflora; 5996* (21) *C. elata; 2122, 3476, 4940, 5960, 6094,* — (22a) *C. sericea* var. *typica; 5927* (31) *C. Bradburiana; 5902* (33) *C. cana; 5980, 6010, 6200* (32d) *C. nana* var. *typica; 6416* (35) *C. breviflora; 6003* (36) *C. fulvocanescens; 4463, 4497, 5975* (40) *C. longiflora; 6138* (42) *C. Osterhoutii; 2610* (44) *C. Bakeri; 2750, 4696, 5956, 6006, 6194, 6197, 6252* (46) *C. flavoculata.*
Over, W. H.
5188, 6185, — (31) *C. Bradburiana.*

Overholts, L. O.
10, 155 (**13**) *C. virgata.*
Palmer, Ed.
591 (**1a**) *C. Jamesii* var. *multicaulis; 375* (**1c**) *C. Jamesii* var. *cinerea; 895* (**3**) *C. Palmeri;* — (**6**) *C. flava; 357, 591* (**12**) *C. setosissima; 189* (**26**) *C. spiculifera; 598* (**32b**) *C. nana* var. *Shantzii.*
Palmer, Wm.
— (**29**) *C. Macounii.*
Parish, S. B.
1480, 3238, 3694 (**1f**) *C. Jamesii* var. *abortiva; 1316, 1319, 3240, 4887, 19167* (**5**) *C. confertiflora; 10243* (**16**) *C. tumulosa.*
Parish, S. B. & W. F. Parish.
1316 (**5**) *C. confertiflora.*
Parry, C. C.
166 (**5**) *C. confertiflora; 173* (**15**) *C. virginensis; 49* (**46**) *C. flavoculata.*
Patterson, H. M.
110 (**13**) *C. virgata;*—(**22a**) *C. sericea* var. *typica.*
Payson, E. B.
1019 (**1c**) *C. Jamesii* var. *cinerea; 1027* (**1e**) *C. Jamesii* var. *typica; 405* (**6**) *C. flava; 1014* (**20**) *C. thyrsiflora; 271* (**36**) *C. fulvocanescens; 35, 659* (**40**) *C. longiflora; 458* (**43**) *C. paradoxa; 1079, 1135* (**44**) *C. Bakeri; 246, 337, 670, 997, 1046* (**46**) *C. flavoculata.*
Payson, E. B. & G. M. Armstrong.
3223 (**19**) *C. caespitosa; 3206, 3224* (**22b**) *C. sericea* var. *perennis.*
Payson, E. B. & E. Bethel.
1608 (**1e**) *C. Jamesii* var. *typica.*
Payson, E. B. & L. B.
2533, 2557, 4307 (**6**) *C. flava; 1880* (**8**) *C. salmonensis; 4248, 4253, 4291* (**13**) *C. virgata; 2578* (**19**) *C. caespitosa; 4246, 4685* (**20**) *C. thyrsiflora; 2528* (**22a**) *C. sericea* var. *typica; 2580* (**22b**) *C. sericea* var. *perennis; 1768* (**26**) *C. spiculifera; 1746* (**29**) *C. Macounii; 4247* (**31**) *C. Bradburiana; 3876* (**36**) *C. fulvocanescens; 4223* (**43**) *C. paradoxa; 3834* (**44**) *C. Bakeri; 1689, 2583, 3865, 3874, 3875* (**46**) *C. flavoculata.*
Pearson, G. A.
210 (**1a**) *C. Jamesii* var. *multicaulis.*
Peck, M. E.
10020 (**27**) *C. celosioides.*
Pierson, F. E.
3103 (**1f**) *C. Jamesii* var. *abortiva.*
Piper, C. V.
2987, — (**7**) *C. leucophaea; 2294* (**28**) *C. Sheldonii.*
Porter, T. C.
— (**22b**) *C. sericea* var. *perennis.*
Pratt, A. D.
— (**31**) *C. Bradburiana.*
Pringle, C. G.
776 (**1b**) *C. Jamesii* var. *laxa;* — (**1a**) *C. Jamesii* var. *multicaulis.*
Purpus, C. A.
6068, 7067, 8048a, 8195 (**1c**) *C. Jamesii* var. *cinerea; 5323, 5802* (**5**) *C. confertiflora; 8048* (**12**) *C. setosissima;* — (**15**) *C. virginensis; 6070* (**32e**) *C. nana* var. *ovina;* — (**32d**) *C. nana* var. *typica;* — (**41**) *C. tenuis; 5869* (**46**) *C. flavoculata.*
Ramaley, F.
A. 107, 1078 (**13**) *C. virgata; 1448* (**20**) *C. thyrsiflora.*
Reverchon, J.
2120 (**3**) *C. Palmeri.*
Rothrock, J. T.
700 (**20**) *C. thyrsiflora.*
Rusby, H. H.
283, 749 (**1a**) *C. Jamesii* var. *multicaulis; 748* (**12**) *C. setosissima.*
Rydberg, P. A.
254, 1514 (**1e**) *C. Jamesii* var. *typica; 255* (**20**) *C. thyrsiflora; 893* (**31**) *C. Bradburiana; 256* (**33**) *C. cana.*
Rydberg, P. A. & E. A. Bessey.
4882, 4883 (**31**) *C. Bradburiana.*
Rydberg, P. A. & E. C. Carlton.
7041 (**1c**) *C. Jamesii* var. *cinerea.*
Rydberg, P. A. & A. O. Garrett.
9569 (**2**) *C. pustulosa; 8431* (**6**) *C. flava; 9130* (**44**) *C. Bakeri.*
Rydberg, P. A. & F. K. Vreeland.
5702 (**1c**) *C. Jamesii* var. *cinerea; 5704* (**20**) *C. thyrsiflora.*

Sandberg, J. H.
— (28) *C. Sheldonii.*
Sandberg, J. H. & J. B. Leiberg
373 (7) *C. leucophaea; 164*,—(26) *C. spiculifera; 440* (27) *C. celosioides.*
Saunders, A. A.
— (29) *C. Macounii.*
Saunders, D. A.
4875 (26) *C. spiculifera.*
Scheuber, E. W.
— (31) *C. Bradburiana.*
Schmoll, H. M.
1281, 1346 (44) *C. Bakeri.*
Schoper, M.
28 (32b) *C. nana* var. *Shantzii.*
Scribner, G. L.
174 (31) *C. Bradburiana.*
Shantz, H. L.
571 (1e) *C. Jamesii* var. *typica.*
Sharp, S. S.
132 (31) *C. Bradburiana.*
Shear, C. L.
4381 (22b) *C. sericea* var. *perennis.*
Sheldon, C. S.
527 (1c) *C. Jamesii* var. *cinerea; 216* (13) *C. virgata; 526* (20) *C. thyrsiflora.*
Sheldon, E. P.
8315 (28) *C. Sheldonii.*
Shockley, W. H.
— (5) *C. confertiflora; 244* (46) *C. flavoculata.*
Slaughter, I. W.
7 (32b) *C. nana* var. *Shantzii.*
Smith, C. P.
7680 (1c) *C. Jamesii* var. *cinerea; 3912* (1e) *C. Jamesii* var. *typica; 3916* (20) *C. thyrsiflora; 1573, 1605* (32b) *C. nana* var. *Shantzii; 3936* (44) *C. Bakeri.*
Sonne, C. F.
— (18) *C. humilis.*
Soth, Mrs. M. E.
P-9 (32b) *C. nana* var. *Shantzii.*
Standley, P. C.
4899, 7125, 7830, 7967 (1a) *C. Jamesii* var. *multicaulis;* — (4) *C. oblata; 6036, 6056* (20) *C. thyrsiflora; 15107, 17423, 17594* (28) *C. Sheldonii.*
Starz, E.
— (29) *C. Macounii.*
Stevens, G. W.
335, 3024, 3039 (1a) *C. Jamesii* var. *multicaulis.*
Stokes, S. G.
— (6) *C. flava;* — (17) *C. humilis;* — (32a) *C. nana* var. *commixta;* — (32b) *C. nana* var. *Shantzii;* — (39) *C. Wetherillii;* — (46) *C. flavoculata.*
Suksdorf, W. N.
407 (7) *C. leucophaea; 888* (27) *C. celosioides.*
Taylor, W. P. & H. C. Bryant.
— (10) *C. nubigena.*
Thompson, C. H.
97 (1e) *C. Jamesii* var. *typica.*
Thurber, Geo.
278, 293 (1a) *C. Jamesii* var. *multicaulis; 147* (4) *C. oblata.*
Tidestrom, Ivar.
2031 (6) *C. flava; 1293, 9610* (46) *C. flavoculata.*
Toumey, J. W.
224 (12) *C. setosissima.*
Tracy, S. M.
7835 (1a) *C. Jamesii* var. *multicaulis.*
Tracy, S. M. & F. S. Earle.
424 (3) *C. Palmeri.*
True, G. H.
865 (18) *C. humilis.*
Turesson, G. W.
— (28) *C. Sheldonii.*
Tweedy, Frank.
576 (1a) *C. Jamesii* var. *multicaulis; 5219* (1e) *C. Jamesii* var. *typica; 4262* (6) *C. flava; 5222, 5223, 5676* (13) *C. virgata; 4260* (19) *C. caespitosa; 3570* (29) *C. Macounii; 816, 3569, 4261,* — (31) *C. Bradburiana; 4259* (46) *C. flavoculata.*
Umbach, L. M.
149 (29) *C. Macounii.*
Vasey, G. R.
— (4) *C. oblata;* — (20) *C. thyrsiflora.*
Visher, S. S.
295, 431, 587 (31) *C. Bradburiana.*
von Schrenk, H.
— (31) *C. Bradburiana.*

Voth, H. R.
15, 103 (6) *C. flava.*
Waldron, C. B.
— (31) *C. Bradburiana.*
Walker, E. P.
85, 156 (36) *C. fulvocanescens; 91* (43) *C. paradoxa.*
Ward, L. F.
393, 557 (1d) *C. Jamesii* var. *disticha; 108,* — (5) *C. confertiflora;* — (6) *C. flava; 646* (12) *C. setosissima; 49* (17) *C. modesta; 87* (46) *C. flavoculata.*
Waring, M. G.
15 (36) *C. fulvocanescens.*
Watson, S.
853 (18) *C. humilis; 852* (22b) *C. sericea* var. *perennis; 287* (28) *C. Sheldonii; 852* (46) *C. flavoculata.*
Webber, H. J.
— (31) *C. Bradburiana.*
White, O. E.
— (31) *C. Bradburiana.*
Whited, Kirk.
1099, — (27) *C. celosioides.*
Wilcox, E. V.
79 (29) *C. Macounii.*
Wilkes, Charles.
(61) 437 (28) *C. Sheldonii.*
Williams, R. S.
109 (28) *C. Sheldonii.*
Williams, T. A.
— (1a) *C. Jamesii* var. *typica;* — (20) *C. thyrsiflora;* — (31) *C. Bradburiana;* — (33) *C. cana.*
Willits, Vie.
92 (29) *C. Macounii; 236* (31) *C. Bradburiana.*
Wolf, John, & Rothrock, J. T.
700 (20) *C. thyrsiflora.*
Wooton, E. O.
401, 595, 2818, — (1a) *C. Jamesii* var. *multicaulis;* — (4) *C. oblata;* — (12) *C. setosissima;* — (29) *C. Macounii.*
Wright, C.
489 (3) *C. Palmeri; 1566* (4) *C. oblata.*
Zuck, M.
— (36) *C. fulvocanescens.*

Index to Species and Varieties

Synonyms are printed in *italics;* species or genera maintained in this paper are printed in Roman type; new species, varieties, or combinations are indicated in **bold face** type.

EXPLANATION OF PLATE

Figures illustrating nutlets of *Cryptantha*, section *Oreocarya*. Each one is illustrated by three figures—a dorsal, lateral, and ventral view. All are drawn to scale, times 10, except fig. 4 of pl. 25 (complete fruit), which is times 7½.

PLATE 25

Figs. 1–4. *C. Jamesii* var. *multicaulis*. Drawn from *Wooton 401*. The nutlets of all the varieties of *C. Jamesii*, *C. pustulosa*, and *C. Palmeri* are very similar, and these figures will serve to illustrate them.

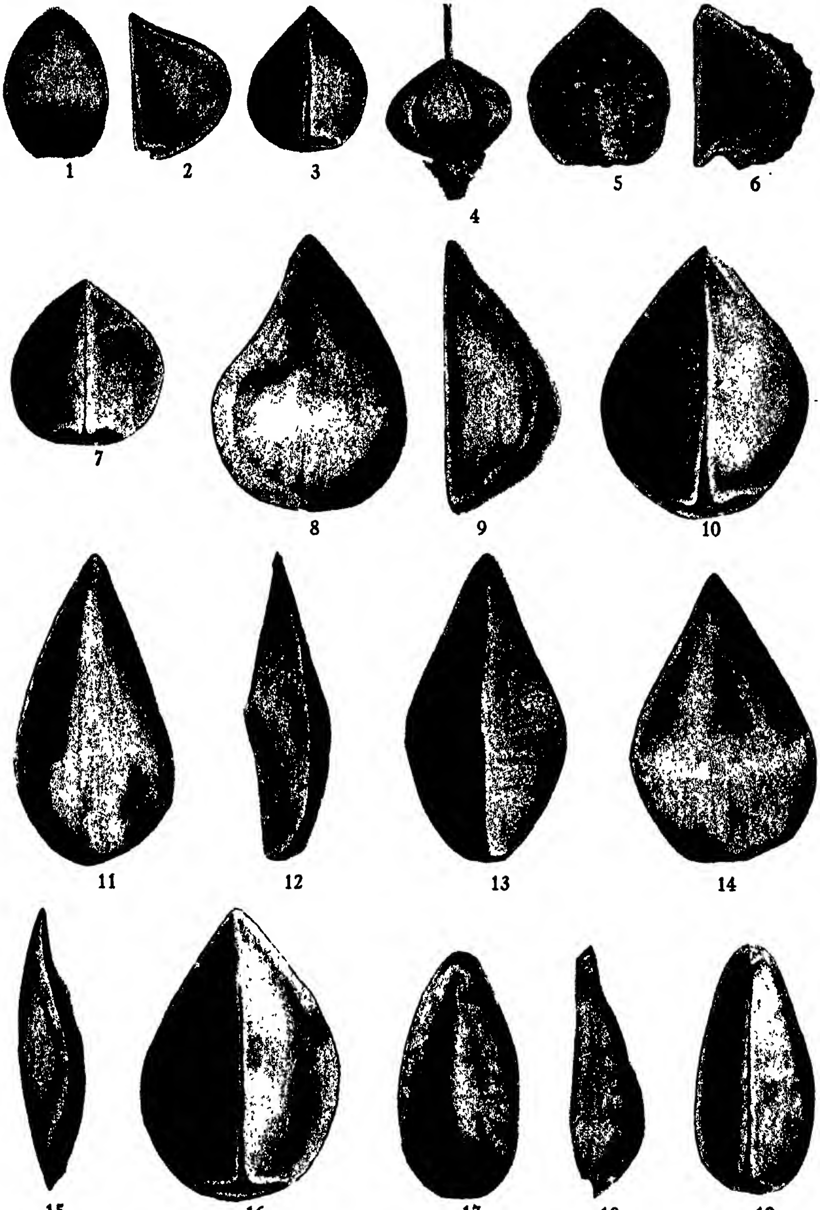
Figs. 5–7. *C. oblata*. Drawn from *Jones 3759*.

Figs. 8–10. *C. confertiflora*. Drawn from *Goodding 814*.

Figs. 11–13. *C. flava*. Drawn from *Goodding 164*.

Figs. 14–16. *C. leucophaea*. Drawn from *Sandberg & Leiberg 373*.

Figs. 17–19. *C. salmonensis*. Drawn from *Payson & Payson 1880*.



PAYSON—SECTION OREOCARYA OF CRYPTANTHA

Explanation of Plate

PLATE 26

Figs. 20–22. *C. stricta.* Drawn from *Osterhout 6195.*

Figs. 23–25. *C. nubigena.* Drawn from specimen collected by *Cusick*, Pine Creek, Oregon.

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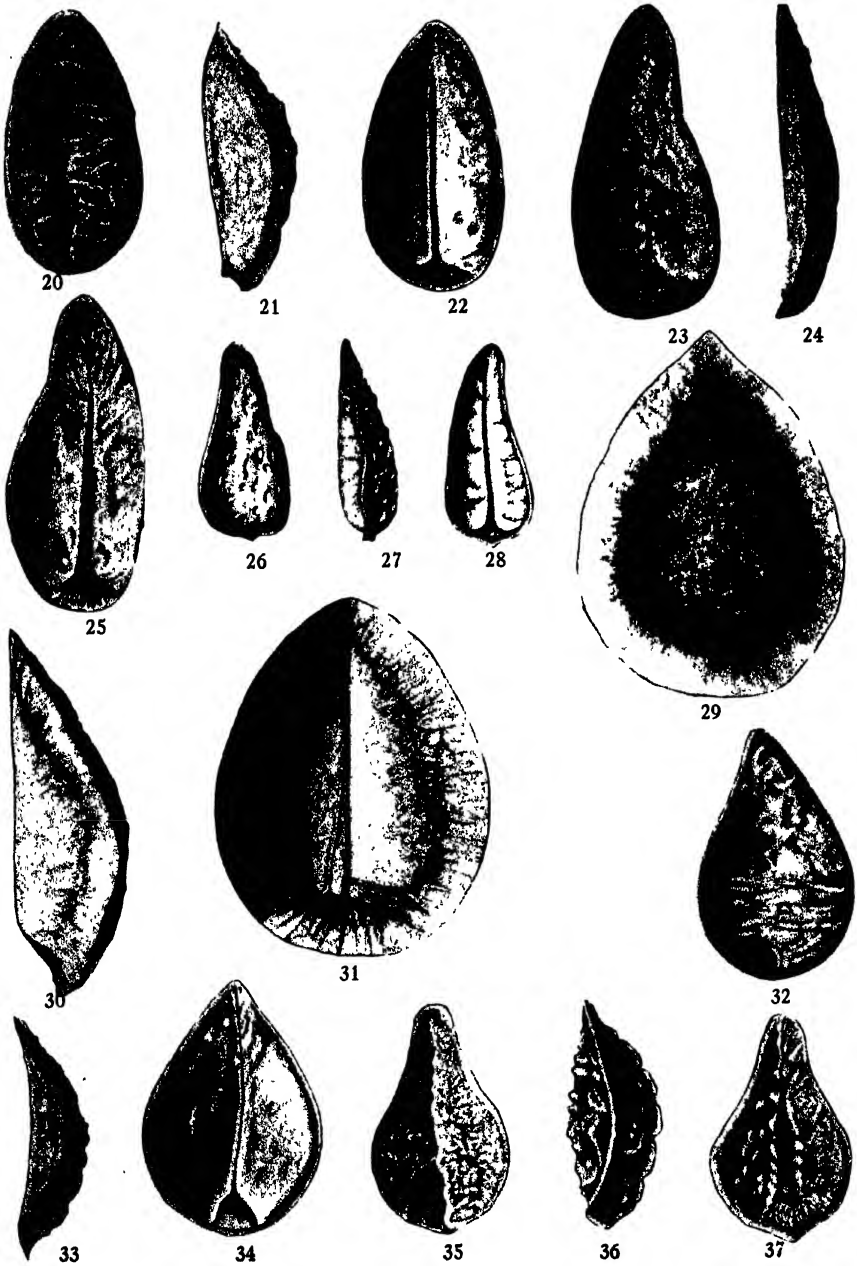
Figs. 29–31. *C. setosissima.* Drawn from specimen collected by *M. E. Jones*, Flagstaff, Arizona, August 4, 1884.

Figs. 32–34. *C. virgata.* Drawn from specimens collected near Laramie, Wyoming, by the author in 1925.

Figs. 35–37. *C. insolita.* Drawn from specimen collected by *K. Brandegee*, Las Vegas, Nevada.



PAYSON—SECTION OREOCARYA OF CRYPTANTHA

Explanation of Plate

PLATE 27

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Figs. 41–43. *C. tumulosa.* Drawn from type, *T. S. Brandegee,* Providence Mountains, California.

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Figs. 47–49. *C. humilis.* Drawn from specimen collected by *Sonne,* along the Truckee River, at Verdi, California.

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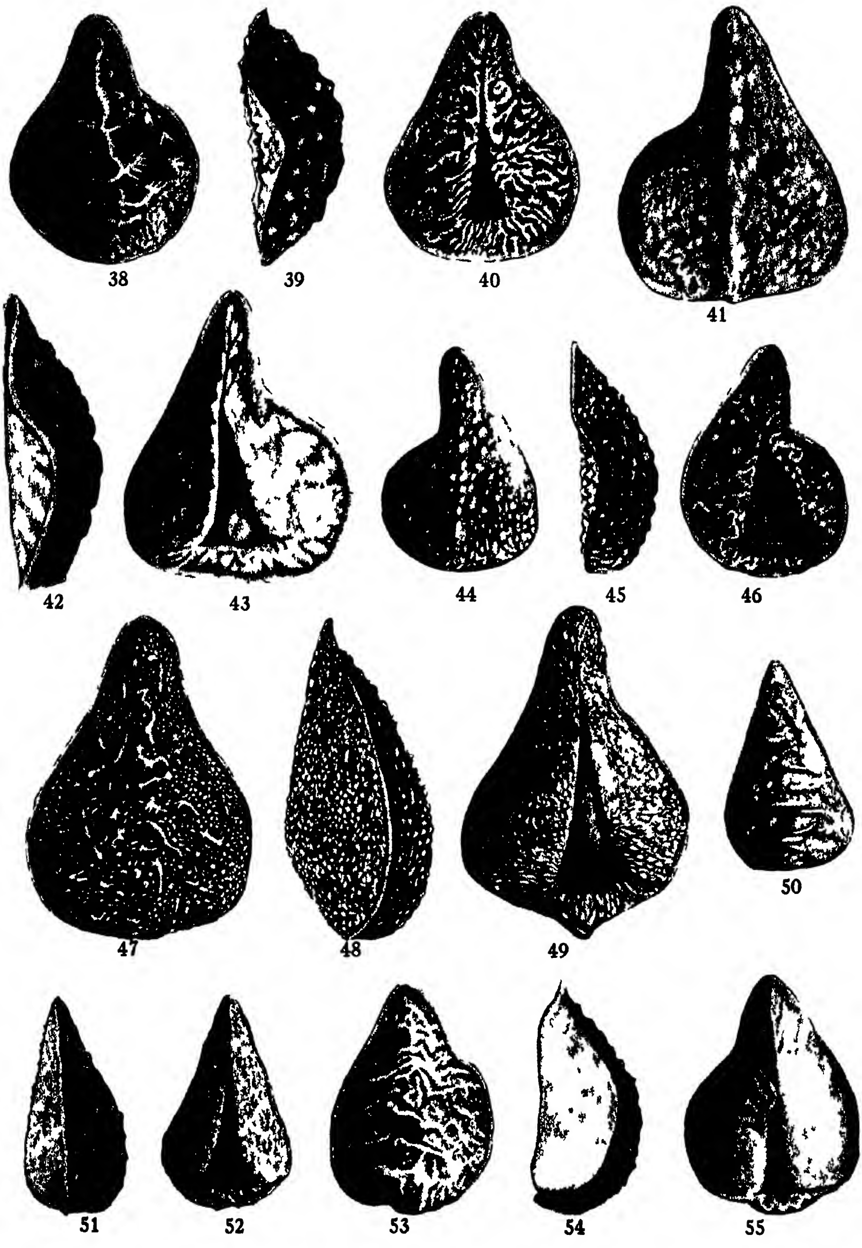
Figs. 53–55. *C. thyrsiflora.* Drawn from *Osterhout 4979.*



PAYSON—SECTION OREOCARYA OF CRYPTANTHA

Explanation of Plate

PLATE 28

Figs. 56–58. *C. elata.* Drawn from *Osterhout 5996.*
Figs. 59–61. *C. sericea* var. *typica.* Drawn from *Payson & Payson 2528.*
Figs. 62–64. *C. aperta.* Drawn from type, *Eastwood,* Grand Junction, Colorado.
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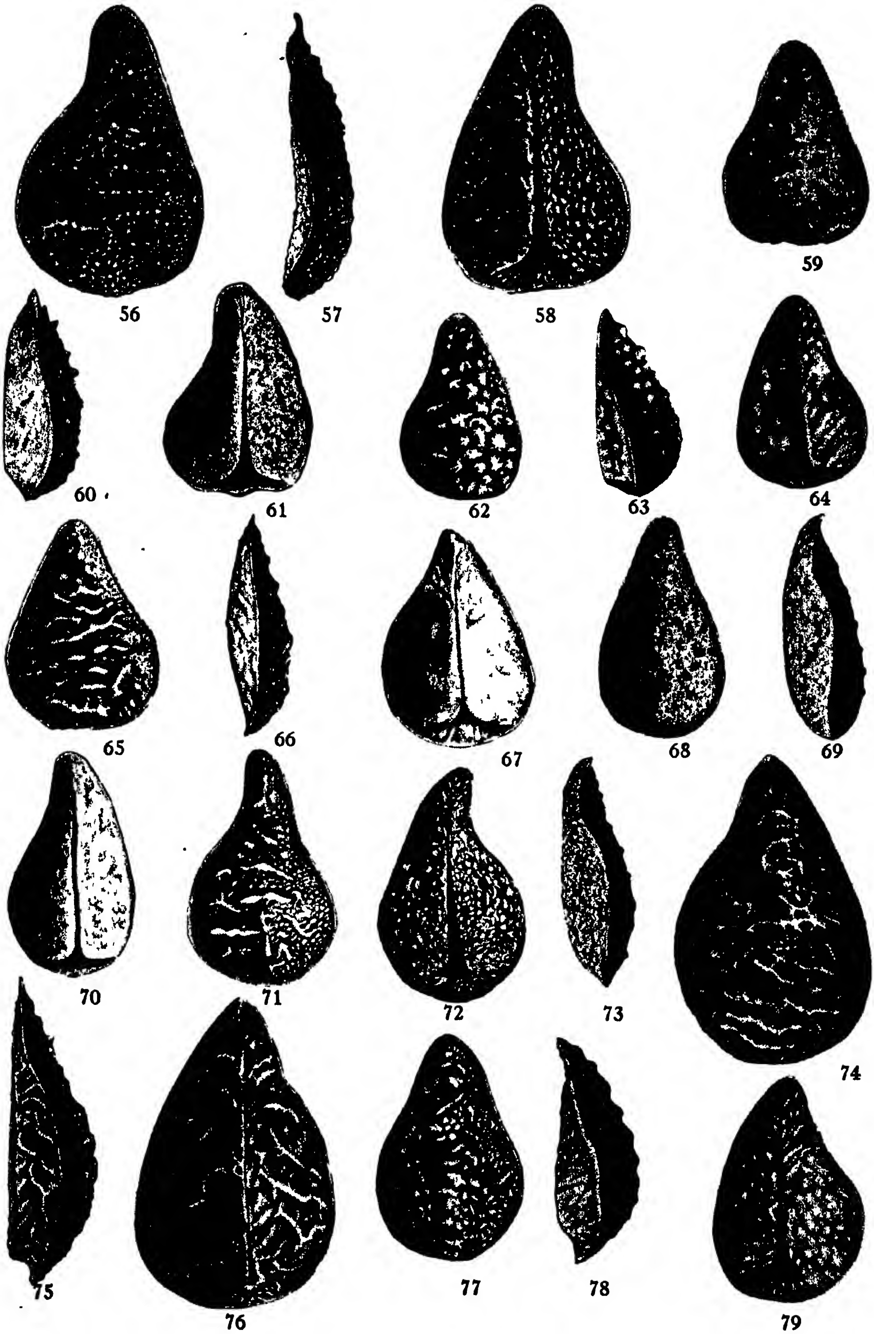
Figs. 77–79. *C. Sheldonii.* Drawn from type, *Sheldon 8315.*



PAYSON—SECTION OREOCARYA OF CRYPTANTHA

Explanation of Plate

PLATE 29

Figs. 80–82. *C. Macounii.* Drawn from specimen collected by *Macoun*, at Moose Jaw, Saskatchewan.

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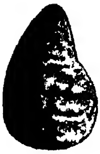
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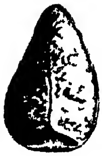
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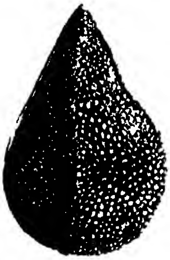
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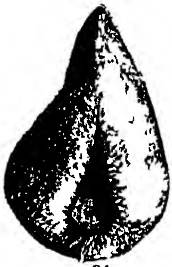
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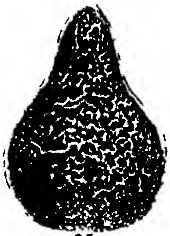
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PAYSON—SECTION OREOCARYA OF CRYPTANTHA

Explanation of Plate

PLATE 30

Figs. 101–103. *C. Wetherillii.* Drawn from type, *Eastwood,* Court House Wash, Utah.
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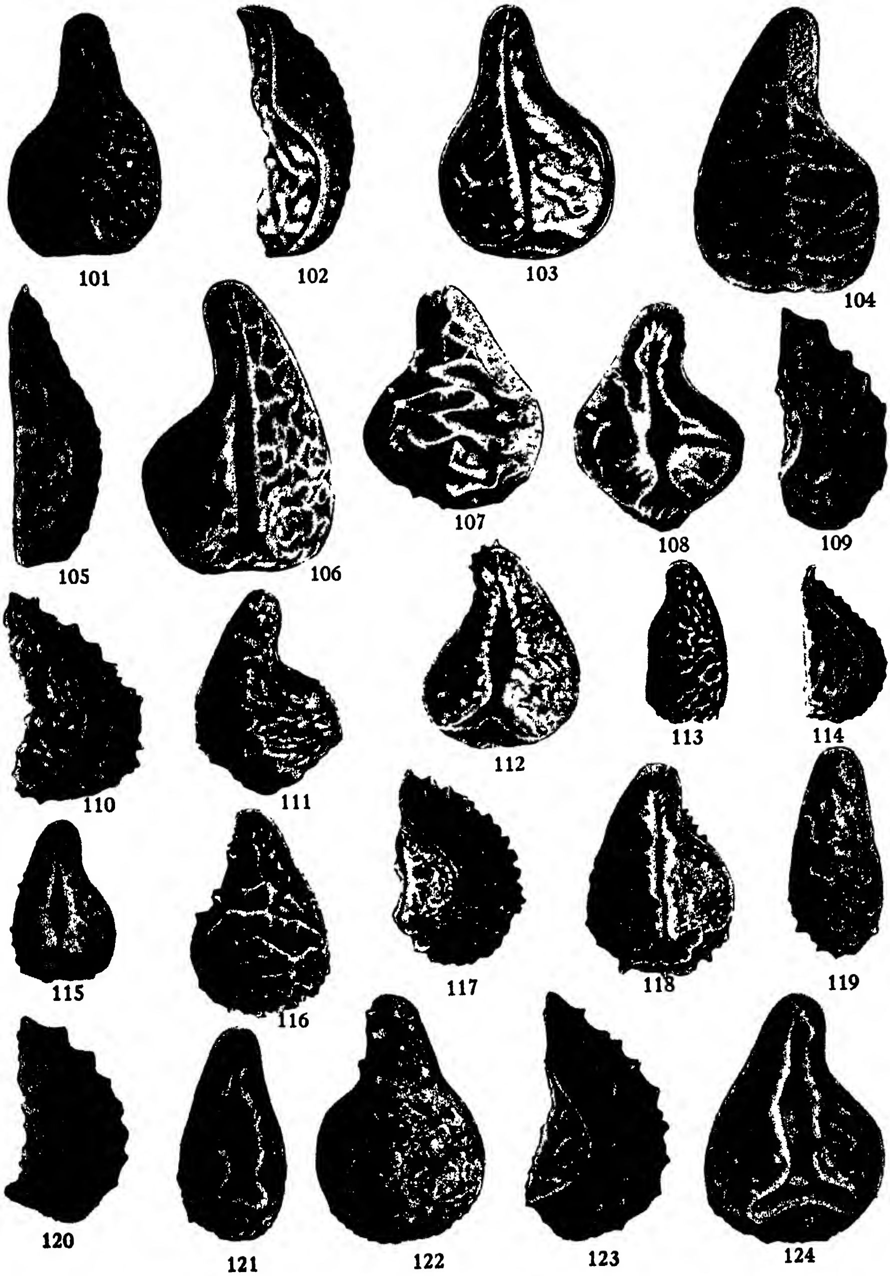

PAYSON—SECTION OREOCARYA OF CRYPTANTHA

Annals
of the
Missouri Botanical Garden

Vol. 14 NOVEMBER, 1927 No. 4

COTTON WILT: A PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATION[1]

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INTRODUCTION

Cotton wilt is undoubtedly the most important disease of the cotton crop in the United States and causes the largest annual loss. According to records of the Plant Disease Survey of the U. S. Department of Agriculture compiled for several years, the disease is widely distributed through the cotton belt from Virginia to Texas, and is apparently spreading from year to year to new localities.

The damage caused by this important disease of cotton varies in different localities each season, but frequently large areas are involved and, without question, the annual loss to the entire cotton belt must reach into the millions of dollars. The estimated reduction in yield in the United States because of wilt was 350,000 bales in 1925. In Mississippi, one of the leading cotton-producing states of the mid-south, the annual loss from this disease is fully 50,000 bales, and it reaches even larger proportions during unusually dry seasons.

In view of the wide prevalence of wilt in Mississippi and other southern states, an investigation of this problem was begun by the writer at the Missouri Botanical Garden in the fall of 1925, where a year was spent in a laboratory and greenhouse investi-

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

gation of this disease and of the causal organism. The study of the problem has been continued since this time at the Mississippi Agricultural Experiment Station. Briefly, the objects of the investigations reported in this paper are: (1) to ascertain some of the physiological relations of the fungus causing the disease, such as growth-temperature relations in pure culture, effects of H-ion concentration upon growth, and the factors involved in producing wilt by the fungus; (2) to determine the pathogenicity of the fungus; (3) to determine the effects of varying conditions of nutrition upon the development of the disease under greenhouse and field conditions; (4) to study differences in varietal susceptibility and resistance in both upland and staple cottons.

Previous Investigations on Cotton Wilt

One of the first investigators to establish the identity and probable relationship of the fungus associated with cotton wilt was Atkinson ('92). He considered the wilting of the plant to be due to the plugging of the vessels of the plant near the base of the stem by the mycelium of a fungus. He made isolations from the tissues of affected plants and described the fungus found as a new species under the name *Fusarium vasinfectum* Atk. Atkinson also found a species of *Fusarium* on the surface of some of the infected plants, but considered this a saprophyte, distinct from the internal fungus. Some years later, Smith ('99) made a more extensive study of the Fusaria found associated with wilt in cotton, in cowpea, and in watermelon. This investigator was under the impression that he had developed the ascigerous stage of the fungus on cotton, and this he designated *Neocosmospora vasinfecta* (Atk.) Smith. He stated that the fungus probably also occurred on okra, but that its parasitism and the genetic connection of the various spore forms were not proved and that chlamydospores were not observed. At the time these investigations were made, Smith seems to have had no doubt as to the parasitic nature of the cotton or cowpea wilt fungus, or as to the genetic relationship of the various spore forms found on cotton. He admitted that these points had not been definitely settled through satisfactory infection experiments, by deriving one spore form from the other in pure cultures. The field evidence, how-

ever, of the parasitic nature of the cotton and cowpea fungus was thought by Smith to be most convincing, since the fungus was always present in the vessels of the diseased plants and the disease occurred year after year on the same soils. More recent studies by Higgins ('09) and Butler ('10) indicate that in all probability there is no genetic relationship between the *Neocosmospora* referred to by Smith and the internal fungus *Fusarium vasinfectum* which Atkinson associated with cotton wilt. Neither did Higgins regard the *Neocosmospora* as having any connection with the wilt of cowpea. In fact, a study of the literature indicates that with cultures of *Fusarium vasinfectum* Atk., isolated from wilted plants and accordingly capable of infecting cotton, perithecia have never been produced. It appears, therefore, that the correct identity of the fungus associated with the wilt disease of cotton should properly date back to Atkinson's work in Alabama in 1892.

Orton ('00) apparently accepted Smith's determination for cotton wilt as *Neocosmospora vasinfecta* and was under the impression that the wilt of okra was caused by the same fungus. He states: "No inoculation experiments have been tried, but in the experience of the writer, okra has never failed to contract the disease when planted in fields infected with the cotton wilt disease."

Orton ('00) studied the period of incubation, or the interval elapsing between the time the young seedlings of cotton were exposed to the attacks of the fungus and the first visible external symptoms. He found that a time interval of forty days or longer was required. He noted the conditions which favored the progress of the fungus through the plant and although these were not fully understood, he states: "From observations that have been made, it is believed that highly fertilized plants, growing vigorously, succumb more readily than those which have grown on poorer soil." Orton also corroborated the work of Smith ('99) and Atkinson ('92) by producing the disease in cotton plants through infection experiments. This was accomplished by inoculating the soil, in which cotton was growing, with pure cultures of *Fusarium vasinfectum*. He conducted experiments with a number of fungicides, spraying these on the plants and

applying them to the soil in the hope of killing the fungus, but none of the results obtained gave promise of combating the disease successfully. The fungicides used were Bordeaux mixture, Bordeaux mixture and sulphur, copper carbonate, copper acetate, lime, sulphur, lime-sulphur mixture, liver of sulphur, iron sulphate, carbolic acid, caustic soda, formalin, and kainit. Fields were selected which were uniformly infested, but the cotton died in both the treated and untreated areas, and no difference traceable to the fungicides used could be observed.

At that time, Orton advocated such hygienic treatment as rotation of crops and the removal of diseased plants, also the avoidance of spread of the fungus by cattle, tools, or through infested manure. Considerable stress was also placed upon developing wilt-resistant selections of cotton. Fulton ('07), working in Louisiana in 1907, advocated the planting of wilt-resistant varieties of cotton and the employment of crop rotation as a method of control.

In 1908, Orton published a popular account of cotton wilt in which the geographical distribution of the disease, amount of loss, symptoms of wilt, and the life history of the fungus, so far as known at the time, were given. The influence of seasonal conditions, the time of planting, soil conditions, and the effect of fertilizers and fungicides upon wilt were noted. Attention was also given to breeding cotton for wilt-resistance, and breeding methods were described.

Lewis ('11) noted the distribution of wilt in Georgia in 1911 and estimated the annual loss in that state to be about three-quarters of a million dollars. He studied the effect of fertilizers on the disease and concluded that various combinations of acid phosphate, muriate of potash, and guano,[1] used at the rate of from 300 to 800 pounds per acre, were of no benefit in controlling it. The test plats were not replicated, however, and the size of the plats in the experiments was not indicated.

Lewis ('15) originated several wilt-resistant varieties of cotton from 1905 to 1915, some of which are still widely planted in the southeastern section of the cotton belt. He used both the method of selection and of hybridization of desirable parent

[1] Mixed fertilizer, 10–2–2.

plants to obtain resistant strains. Doubtless his better-known wilt-resistant cottons are Lewis 63, Dix-afifi, and Council Toole.

Rast ('22) conducted some fertilizer experiments in Arkansas in 1920 on the control of cotton wilt, which apparently were beneficial. A portion of a field was observed by him in 1920 in both fertilized and unfertilized areas heavily infested with wilt. The grower had used 500 pounds per acre of a mixture containing 10 per cent phosphoric acid, 3 per cent nitrogen, and no potash. So many plants in this field on both the fertilized and unfertilized areas died in 1920 that no record was kept of the yield of cotton. The experiment had been planned to run on this area for 5 years, and it was necessary to change radically the plan of the experiment in order to justify the continuance of the work. It was suggested that 500 pounds of the same fertilizer that was used in 1920 (containing 10 per cent phosphoric acid, 3 per cent nitrogen, and no potash) be mixed with 500 pounds of kainit containing 12.5 per cent potash. This mixture contained, as shown by analysis, 5 per cent available phosphoric acid, 1.5 per cent nitrogen, and 6.25 per cent potash. It was applied in the spring of 1921 at the rate of 1000 pounds per acre before planting. His results are quoted: "The plants on the unfertilized area began to die long before they were mature and were evidently infected with the wilt disease. By harvest time, no less than 95 per cent of the plants on the unfertilized area were dead and not a dead plant could be found in any part of the field where the fertilizer was used. The fertilized area produced 1127 pounds of seed cotton per acre; whereas the disease-infested part of the field to which no fertilizer was applied produced only 225 pounds of seed cotton per acre. Plants on an adjoining area to which 500 pounds per acre of fertilizer containing 10 per cent available phosphoric acid, 3 per cent nitrogen, and no potash were applied before planting and to which 500 pounds per acre of kainit were used as an additional application after the plants were up and growing, were equally resistant to the disease and just as prolific." Rast concluded that the above results were due to the potash in the fertilizer, and Elliott (Rast, '22, p. 224) who examined the plats, wrote as follows: "I do not attempt to make an explanation of the facts, but to all appearances the treatment the kainit plat

received enabled the plants this year to very largely escape wilt infection."

DESCRIPTION OF COTTON WILT

A noticeable yellowing of the leaves of the cotton plant accompanied by a stunted appearance somewhat early in the season is usually a good indication of *Fusarium* wilt. The disease may be noted at first in irregular spots over the field, and each succeeding year these infested areas enlarge. Frequently the main stem of plants infected with the disease remains short, while some of the lower branches grow normally (pl. 31, fig. 1). It is, however, by means of the internal appearance of affected cotton plants that we obtain the most characteristic symptom of wilt. If the stem of a freshly wilted plant is cut across near the ground and a brown or black discoloration of the fibro-vascular tissues is found, there is strong evidence of the disease (pl. 31, fig. 2). The tap-root of infected plants is shorter and the lateral roots less abundant. If plants are examined late in the season at the time they are approaching maturity, the wilt fungus may frequently be observed not only in the lateral and tap-roots, but in the vascular tissues of the main branches, the leaf petioles, and pedicels.

MORPHOLOGICAL AND CULTURAL CHARACTERS OF THE FUNGUS

The fungus, *Fusarium vasinfectum* Atk., the pathogen responsible for the occurrence of cotton wilt, has not been made the object of extensive morphological or taxonomic study by the writer. It seems desirable, therefore, to accept the criteria of taxonomic differentiation of species as established through the work of Wollenweber and associates ('25). The fungus is accordingly placed in section Elegans of the genus *Fusarium*. Growth of the fungus is usually rapid on a variety of complete nutrient media, and both micro- and macro-conidia are produced readily in culture. Micro-conidia are present on the aerial mycelium and are dominantly non-septate, ovoid to fusoid, 4–6 × 3–4.5 μ. Macro-conidia are usually none to 3-septate, attenuate at distal end, pedicellate, fusoid to sickle-shaped, 20–25 × 4–6 μ. Chlamydospores are produced in cultures 3 weeks old or less and may be either terminal or intercalary (pl. 32,

figs. 3–4). The color of the stroma is marked, and on sterilized rice the acid modification is especially well developed, the rose-red to wine-red color appearing in this medium in from 8 to 12 days after the fungus is introduced. The aromatic odor of the fungus when grown on rice is pronounced. On nutrient and bean agar the color of the mycelium is white, but on starchy media, such as potato-dextrose and corn-meal agar, the mycelium is tinged noticeably purple.

SOURCES OF CULTURES

Several strains of *Fusarium vasinfectum* have been used during the progress of this investigation. On September 15, 1925, the writer isolated the fungus from the stem tissues of a Cook Triumph hybrid cotton plant growing in a breeding plot of the Experiment Station, A. & M. College, Mississippi, and later established the pathogenicity of this culture by a series of infection experiments. This isolation has been used very largely in the earlier phases of the investigation and particularly in the laboratory studies of the fungus. On July 15, 1926, the fungus was isolated from a wilted plant of Trice cotton in the breeding plot at the Experiment Station, A. & M. College. It was also isolated from a wilted plant of Delfos 6102 cotton collected at Dunleith, Mississippi, on August 16, 1926, and from Trice cotton growing at Poplarville, Mississippi, on August 12, 1926. Strains of the fungus supplied by Dr. V. H. Young and Dr. H. R. Rosen, of the Arkansas Experiment Station, have been included in some of the experiments. The pathogenicity of all cultures was later established by infection experiments.

The method of isolation may be briefly described as follows: Cotton plants showing unmistakable symptoms of wilt were collected and free-hand sections made of the stem tissue and occasionally the leaf petioles. The sections with typical vascular discoloration were treated from 3 to 5 minutes in a 1 : 1000 solution of mercuric chloride (holding with sterile forceps), rinsed in sterile distilled water, and placed on nutrient, bean, and potato-dextrose agar in Petri dishes. As a disinfecting agent in the preparation of material, calcium hypochlorite has also been used extensively in making isolations, and is equally satisfactory for the purpose.

Physiological Studies of the Fungus

INFLUENCE OF TEMPERATURE

Temperature relations of many organisms causing plant diseases are important in that the geographical distribution of these diseases may be influenced very largely by their thermal relations. For instance, it is a well-known fact that many of the Fusarium diseases develop in destructive form only during periods of prolonged hot weather when soil temperatures are high, whereas others may require moderately cool temperatures to attain the maximum degree of development necessary for infection.

A very large amount of work has been reported by various investigators on temperature relationships of many fungi causing plant diseases, and particularly is this true of the Fusarium group of diseases. It is impossible to go extensively into the literature on this subject in the scope of this paper, but the work of a few investigators may be noted:

Gilman ('16) found that *Fusarium conglutinans* Wollenw., the fungus causing cabbage yellows, has a high optimum temperature and is very resistant to drying both in pure culture and in the soil. The occurrence and development of the characteristic symptoms of the disease required a temperature of about 17–22° C. or higher. Lower temperatures (12–16° C.) under controlled conditions prevented the occurrence of the trouble in the greenhouse. Field observations made over a period of years bore out this relation between the occurrence of the disease and high temperature.

Edgerton ('20) has worked on the temperature relations of tomato wilt, and he and other investigators state that the tomato wilt fungus, *Fusarium Lycopersici* Sacc., is more commonly found in the warmer regions throughout the world. He finds that this fungus grows best at a temperature around 29° C. and that infection also takes place quicker and the disease develops in plants more rapidly if the soil is kept around that temperature. Very little development of the disease is noted at lower temperatures.

Tisdale ('23) found that cabbage yellows is often most destructive in Wisconsin during midsummer when the soil is dry and hot. On the other hand, there is little or no development of the disease, even on soils heavily infested with the organism,

during moist, cool weather. This author emphasizes the importance of the temperature relation of this fungus in the geographical distribution of the disease. For instance, in the southern states, where cabbage is generally grown commercially as a winter or early spring crop, the soil temperature is very probably too low for the organism to gain a foothold on such plants. However, when once introduced, the *Fusarium* establishes itself on summer-grown cabbage and other related hosts and attacks the crop whenever soil temperatures are favorable.

Clayton ('23) found somewhat similar temperature relations with the tomato-wilt fungus as did Edgerton ('20), but noted that the most favorable temperatures of soil and air, as determined in tanks in the greenhouse, are 27° C. and 28° C. respectively, i.e., after the fungus was established in the stems of the plants.

Jones and Tisdale ('22) found that in the case of flax wilt caused by *Fusarium Lini* Bolley, the disease was aggravated by hot seasons and that the midsummer temperature in the regions where it occurred corresponded closely with the optimum for the fungus.

In view of the rather extensive investigations which have been made on the *Fusarium* wilts of other crops, it was interesting to study some of the temperature relations of the cotton-wilt fungus, *Fusarium vasinfectum*. Moreover, it has been noted by the writer not only in Mississippi, but in Alabama, Louisiana, Arkansas, and Texas, that wilt of cotton is usually more prevalent during prolonged periods of dry, hot weather. Particularly was this true in the Gulf Coastal States during the years of 1924–25, two seasons which were notable because of extended periods of dry weather and abnormally high temperature during the greater part of the summer.

In studying the effects of temperature upon the development of the fungus in pure culture, uniform Petri dishes containing a measured amount (10 cc.) of potato-dextrose agar were used. In order to obtain spores of the fungus free of mycelium, a suspension of the spores was made in test-tubes containing 3 or 4 cc. of sterile distilled water. The spore suspension was made from a 7-day-old culture of the fungus growing on steamed rice. In one Petri dish, a thin layer of nutrient agar was poured and then

several loopfuls of the spore suspension were placed at random over the surface of the plate. As soon as the agar solidified, the plates were examined by the low power of the microscope, and single spores were located. These areas were immediately marked by means of a blue wax pencil and the agar blocked out by means of a needle and transferred to the center of the Petri dishes. Each temperature series was run in triplicate and measurements of the growth of the colonies of the mycelium were made at the end of 2, 6, 10, and 15 days. The results are given in table I.

TABLE I

GROWTH OF FUSARIUM VASINFECTUM AT VARIOUS TEMPERATURES

Temperature degrees C.	Diameter of colony in cm. at indicated intervals											
	2 days			6 days			10 days			15 days		
	Plate No.			Plate No.			Plate No.			Plate No.		
	1	2	3	1	2	3	1	2	3	1	2	3
6	0	0	0	0.2	0.2	0.2	1.2	1.5	1 2	1.5	1.6	1.6
10	0.4	0.3	0.2	1.8	1.9	1.8	2.5	2 8	2.9	3.8	3.6	3.4
15	1.9	1.8	1.8	3.8	3.7	3.9	5.4	5.2	5.4	8.2	8.0	8.1
20	3.1	3.2	3.1	7.0	7.2	7 0	9.0*	9.0*	9.0*	9.0*	9.0*	
24	3.8	3.7	4.0	7.8	7.5	8.0	9.0*	9.0*	9.0*	—	—	—
28	4.1	4 0	4.5	7.9	8.0	8.2	9.0*	9.0*	9.0*	9.0*	9.0*	†
30	3.8	3.7	4.0	7.7	7.5	8.0	9.0*	9.0*	9.0*	9.0*	9.0*	—
35	1.8	1.4	1.6	3.2	3.3	3.6	3.5	3.0	3.5	—	—	—
40	0.0	0.0	0 0	0.0	0 0							

* Growth over plate.
† Contaminated.

It will be noted from the above results that *Fusarium vasinfectum* grows very slowly at the lower temperatures, and that the optimum is not far from 28° C. The optimum temperature, therefore, of the parasites of the very similar Fusarium diseases of cotton, tomato, flax, and cabbage is practically the same in pure culture, although the host plants have quite different temperature relations. This fact is supplemented by the work of Edgerton ('20), Tisdale ('23), and others. The maximum temperature of *Fusarium vasinfectum* is apparently around 38° C.

The effect of temperature on the growth of *Fusarium vasinfectum* was also studied by means of liquid cultures. The dry weight of the fungous mat was ascertained at various tempera-

tures ranging from 6 to 40° C. at intervals of 5, 10, and 15 days. Duggar's[1] solution was used for growing the fungus and the final concentration of chemicals used in this solution was as follows: M/4 dextrose, M/5 KNO_3, M/20 KH_2PO_4, M/100 $MgSO_4$, and a trace of $FePO_4$. For obtaining these dilutions the following stock solutions were prepared: M/2 dextrose, M/1 KNO_3, M/4 KH_2PO_4, M/10 $MgSO_4$, and M/1000 $FePO_4$. For 50 cc. of medium the following amounts of these solutions were used: 25 cc. dextrose, 10 cc. KNO_3, 10 cc. KH_2PO_4, 5 cc. $MgSO_4$, and 6 drops $FePO_4$. Pyrex flasks were used for the cultures, and these were run in triplicate at each temperature. A copper-lined, differential incubator with compartments was used in these experiments. It was heavily insulated with asbestos; and had an ice chest at one end and on the opposite end a compartment for water was heated by a small gas burner regulated by a thermostat. With such radiation almost any temperature could be maintained by simply increasing or diminishing the size of individual compartments opposite the ice chest and water-heated unit. The flasks were inoculated with a 7-day-old culture of the fungus by means of a sterile needle in the usual manner, and care was taken to introduce approximately the same amount of the inoculum into each flask. At the intervals indicated, the mats were collected on a filter paper by means of a Buchner filter, dried to constant weight in a Fries oven, and weighed.

Using the dry weight of the fungous mat as an index, it will be

TABLE II

GROWTH OF FUSARIUM VASINFECTUM AT VARIOUS TEMPERATURES

Temperature degrees C.	Dry weight of fungous mat in milligrams		
	5 days	10 days	15 days
6	6.20	54.9	81.4
10	28.0	84.5	97.1
15	35.8	98.7	145.2
20	38.2	149.4	251.5
25	49.5	112.3	455.2
28	226.0	338.6	610.0
30	382.3	493.7	725.2
35	286.5	294.2	422.9
38	172.0	247.3	*——

* Contaminated.

[1] A nutrient solution for fungi recommended by Dr. B. M. Duggar.

noted again that the optimum temperature for *Fusarium vasinfectum* is around 28 and 30° C. It grows slowly at temperatures below 10° C.; the growth curve begins to fall sharply at about 30° C., while at 38° C. it falls off abruptly. The results are graphically illustrated in fig. 1.

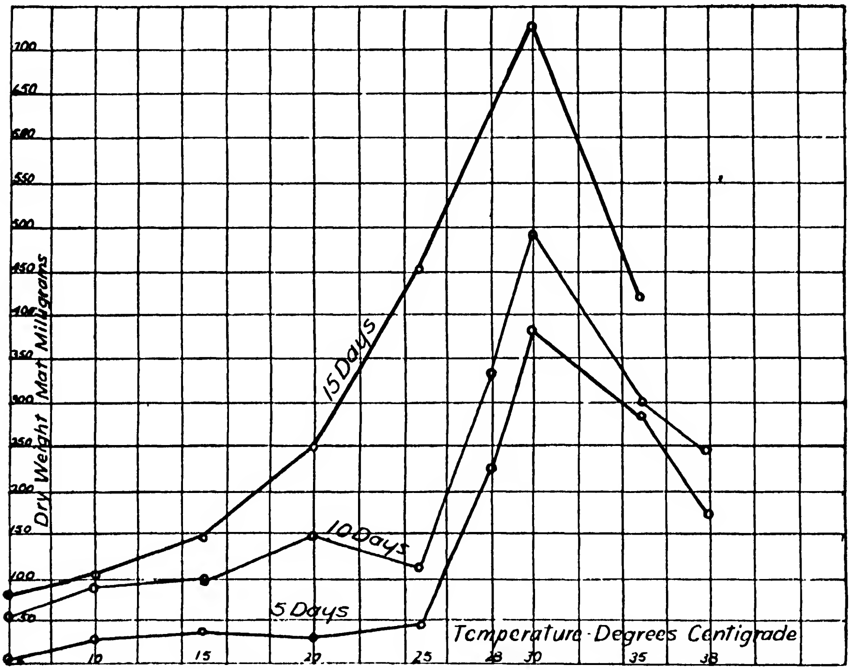

Fig. 1. Showing the effect of temperature on the growth of *Fusarium vasinfectum.*

RELATION TO HYDROGEN-ION CONCENTRATION

The effect of the hydrogen- and the hydroxyl-ion concentration upon the germination of the spores and growth of various fungi has been demonstrated by numerous investigators. That the reaction of the substratum is a very important factor in influencing the growth of many disease-producing organisms is a well-known fact. The literature bearing upon this subject is rather extensive, and has been reviewed to advantage by Webb ('19, '21), Lehman ('23), and others. Webb ('21) finds that with a certain *Fusarium* sp., germination is equally as good, if not better, with an alkaline reaction. However, with the majority of fungi he

employed the maximum for germination was between $P_H 3.0$ and 4.0.

Hopkins ('21), using a synthetic medium in which the hydrogen-ion concentration was adjusted by means of KH_2PO_4, K_2HPO_4, H_3PO_4, and KOH, found that a *Fusarium* isolated from scabby wheat, but not proved to be *Gibberella*, exhibited a similar depression in the growth-acidity curve as did *Gibberella saubinettii*, the wheat-scab organism. In the case of the latter, the amount of growth increased with decreasing acidity from $P_H 2.5$ to a maximum of P_H 4.0–4.5. It then decreased to a minimum at P_H 5.0–5.5 and rose again to a second maximum, but the highest point was not determined.

MacInnes ('22) observed that a strain of *Fusarium* isolated from scabby wheat in Minnesota was capable of growing in solutions varying through an unusually wide range of hydrogen-ion concentrations. The organism grew in nutrient media ranging from P_H 5.0 to P_H 11.7. No determinations were recorded for hydrogen-ion concentrations on either side of these values.

Kirby ('22) found that the maximum hydrogen-ion concentration for *Fusarium moniliforme* on corn was near 8.2, and the range of growth was greater than P_H 5.2–9.2.

The results of the above-mentioned investigations and many others clearly indicate that many fungi require varying degrees of acidity in the substratum for optimum growth, whereas others flourish to better advantage in an alkaline medium or in one approaching the neutral point. In the case of the organism causing the "take-all disease" of wheat, Kirby ('22) states that the fungus requires alkalinity for optimum growth, and that may explain why additions of alkaline substances to the soil have been reported as favoring the fungus, while additions of acid-forming substances decrease the amount of infection. From the work of numerous investigators, notably Martin ('20, '21), Lint ('14, '15, '16), and others, it is known that there is a correlation between increase in soil acidity and a decrease in the prevalence of the potato-scab organism, *Actinomyces scabies*. According to Chupp ('25) and others, a neutral soil with P_H value of 7 will almost invariably give a crop 100 per cent scabby, while an acid one with a P_H value of 5.6 or greater will produce an almost clean crop.

In order to gain an idea of the limiting hydrogen-ion concentration for the growth of *Fusarium vasinfectum* some growth tests were made. Duggar's solution previously referred to was used and contained inorganic salts and dextrose in the following volume molecular concentration: M/4 dextrose, M/5 KNO_3, M/20 KH_2PO_4, and M/100 $MgSO_4$. Six drops of M/1000 $FePO_4$ were used for each 50 cc. of solution, and M/5 $Ca(NO_3)_2$ was substituted for the M/5 KNO_3. The inorganic salts were Merck's "blue label" reagent grade, and the dextrose was the grade designated as "difco standardized." The nutrients were prepared in 500-cc. Pyrex flasks in quantities of 475 cc. for each series, and this quantity of solution was adjusted to the desired P_H value by the addition of previously determined amounts of 0.1647 *N* H_3PO_4 or 0.1613 *N* KOH. The range of initial P_H values was from 2.5 to 9.0 After P_H adjustments were made, the 400 cc. of nutrient solution were divided as follows: 50 cc. of the solution were pipetted into each of eight 125-cc. Pyrex flasks so as to have each series in duplicate for examination after certain growth periods. The remaining 75 cc. of solution of each initial P_H value were put into Jena test-tubes and sterilized for 30 minutes at 15 pounds pressure in order to note the effect of sterilization upon P_H and to serve as controls for final P_H reading at the end of designated growth periods. It was found that autoclaving did not change the P_H appreciably in the tubes, but to guard against enolization of sugars in the alkaline ranges, it was deemed best to sterilize the dextrose portion separately for each flask. This was added later to the solution of salts by means of a sterile pipette.

The cultures were inoculated with a spore suspension of *Fusarium vasinfectum* in sterile distilled water, one loopful being added to each flask, and placed in the incubator at a temperature of 29° C. The cultures were also wrapped with carbon paper to exclude the light from the bulbs. Two flask cultures from each series were examined at the end of 8, 12, 16, and 28 days, and the dry weight of mat, hydrogen-ion concentration, and titrable acidity were determined at each examination. The P_H values were determined colorimetrically by the method of Clark and Lubs ('17).

By means of a Buchner suction filter, the mats were collected on filter-paper, the dry weight of which had been previously determined. The mats were dried for 3 days in a Fries oven at 100° C., cooled in a calcium chloride desiccator for a uniform period, and weighed. The filtrate from each mat was diluted to 100 cc. with distilled water and the total acidity was determined by titrating a 10-cc. aliquot of the filtrate with N/50 KOH, using phenolphthalein as an indicator. The amount of unused sugar present at each interval was also determined for series 2, 7, and 12, and for these determinations the method of Shaffer and Hartman ('21) was employed. The data obtained are shown in table III.

TABLE III

GROWTH OF FUSARIUM VASINFECTUM IN NUTRIENT SOLUTION*

Series No.	Initial P_H	Growth period days	Dry wt. mat mgms.	Final P_H	Cc. N/50 KOH to neutralize 10 cc. filtrate	Wt. of sugar per cc. of solution mgms.
1	2.5	8	49.0	2.9	19.45	
		12	121.3	2.9	18.07	
		16	387.4	3.0	19.00	
		28	348 4	6.6	11.2	
2	2.8	8	49.6	3.2	19.9	43.2
		12	145.0	3.4	17.6	24 0
		16	385.0	3.4	16.5	2.24
		28	397.0	6.2	11.9	0
3	3.0	8	51.2	3.5	16.3	
		12	301.0	5.5	13.4	
		16	414.0	5.8	13.1	
		28	756.3	6.4	5.4	
4	3.5	8	112.2	4.6	16.6	
		12	343.5	5.7	14.2	
		16	417.1	5.8	13.6	
		28	761.0	6.9	1.2	
5	4.0	8	116.0	4.5	16.8	
		12	345.2	5.8	13.4	
		16	419.0	5.8	14.2	
		28	758.3	7.3	.8	
6	4.5	8	122.3	5.3	14.9	
		12	357.2	6.6	10.7	
		16	418.2	6.9	3.9	
		28	747.0	7.4	1.9	
7	5.5	8	133	5.3	15.2	28.08
		12	362.3	6.6	9.8	4.8
		16	413.0	6.8	7.1	2.88
		28	732.6	7.2	2.3	0

TABLE III (Continued)

Series No.	Initial P_H	Growth period days	Dry wt. mat mgms.	Final P_H	Cc. N/50 KOH to neutralize 10 cc. filtrate	Wt. of sugar per cc. of solution mgms.
8	6.0	8	195.0	5.6	14.7	
		12	380.0	6.4	5.9	
		16	441.6	6.4	6 1	
		28	577.8	7.3	3.7	
9	6.5	8	199 0	6.2	10.6	
		12	353.0	6.6	9.9	
		16	434.1	7.2	3.9	
		28	452.0	7.4	1.3	
10	7.0	8	189	6.4	4 3	*
		12	318	6.4	4.35	
		16	447	6.2	8 6	
		28	512	7.2	1.75	
11	7.5	8	144	6 4	3 4	
		12	358	6.2	9 6	
		16	455	6.3	9.4	
		28	502	7.4	0.30	
12	8.5	8	109	6.9	3.8	30.2
		12	299	7.0	.4	22.2
		16	421	7.6	.55‡	9.8
		28	529	8.4	1.3‡	0
13	8.8	8	87	6 7	5.2	
		12	257	6 9	2.7	
		16	405	†—	—	
		28	487	8.5	1.2‡	
14	9.0	8	96	8.4	.95‡	
		12	251	7.9	.70‡	
		16†	—	—	—	
		28	427	7.8	.85‡	

* The values given are the averages of 2 cultures.
† Contaminated.
‡ .2 *N* HCl.

The relations of time to growth in the series are shown in the curves in fig. 2. At the end of the 28-day period, the best growth, as indicated by the dry weight of mat, occurred in series 3–8 inclusive, represented by P_H values of 3.0, 4.0, 4.5, and 5.5. The maximum growth occurred in the cultures started at P_H 3.5. The growth of the fungus was slow in series 1, 2, and 3 for the first 8 days, but later the growth rose rapidly and reached a maximum at the end of 28 days as high as other series started with higher P_H exponents. Judging from the behavior of the cultures in series 1 and 2, the fungus tolerates a culture solution

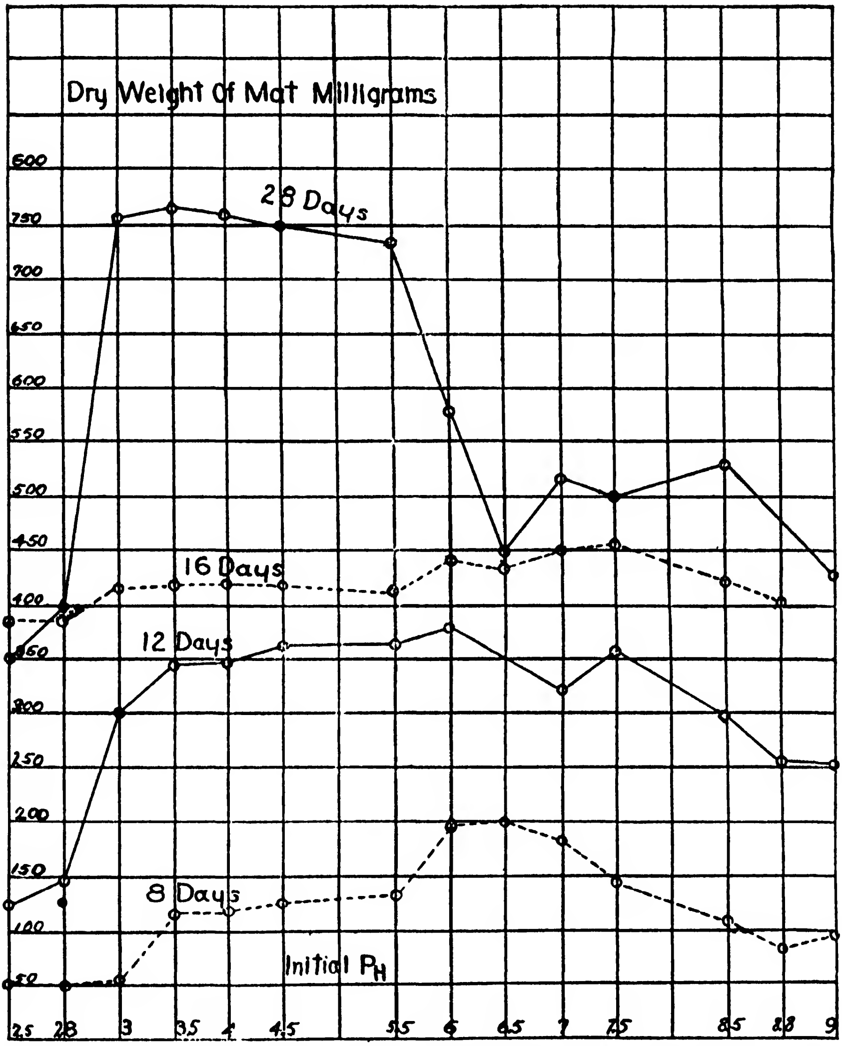

Fig. 2. Showing the relation of time to the growth of *Fusarium vasinfectum.*

strongly acid. However, the maximum growth attained at the close of the experiment was notably less with the more acid cultures. All series initially acid became less so, while all initially alkaline became slightly acid excepting a few started on the extreme alkaline side of P_H 7, which, although becoming acid at first, reversed the reaction later and were distinctly alkaline at the close of the growth period.

In the majority of the series changes in total acidity were closely correlated with changes in hydrogen-ion concentration. Decrease in the amount of sugar in the culture was also correlated with an increase in dry weight of mat. At the close of the experiment (28 days) sugar had entirely disappeared from the culture solution.

FACTORS INVOLVED IN PRODUCING WILT

The wilting in the case of many Fusarium diseases of plants has been explained by numerous plant pathologists and botanists as being due to mechanical plugging up of the vascular system by the vegetative growth of the fungus. Smith ('99) suggested this theory in the case of cotton, cowpea, and watermelon plants, which were infected with closely related fungi of the genus *Fusarium*. He found considerable mycelium within the water-conducting tubes, and assumed that the amount present was sufficient to act as an obstruction of liquid upward, thus causing the condition known as wilt. Among others who have held similar views in the past in connection with cotton wilt are Duggar ('09), Stevens ('21), and Orton ('00, '08, '12). It may be stated in fairness to the above investigators that in the case of the majority of the Fusarium diseases, this idea was generally held by botanists and plant pathologists until a few years ago; the writer is fully aware, too, that some of the investigators mentioned above, perhaps all of them, no longer hold such views.

The theory that the wilting may be due to simply mechanical plugging of the water-conducting vessels of the plant, however, has recently been questioned by a number of investigators, and the numerous experiments along this line have been concerned with a number of Fusarium wilt diseases of plants of very diverse habitat. Because of the fact that the writer has frequently observed considerable fluctuation in the prevalence of cotton wilt in fields which were known to be infested, and the fact that the disease has appeared to be more severe during dry seasons, especially in recent years, it was of interest to make some studies regarding the phenomena concerned in wilting by *Fusarium vasinfectum*.

If the cause of wilting was simply a response to mechanical

obstruction, it is conceivable that with ample moisture, there would perhaps be a greater vegetative growth of the fungus within the tissues and a corresponding increase in wilt because of greater obstruction by the mycelium. In this connection, observations made in Mississippi by the writer are somewhat in disagreement with the statement by Elliott ('21). He remarks: "It is a well observed fact that cotton wilt is more severe in a wet season than in a drier one. The reason for this is because the weather conditions which favor a rapid 'sappy' growth of the cotton plant also favor the development of the wilt fungus, and if the water supply becomes at all short, such plants suffer quickly and severely." Observations made in Mississippi and other states lead the writer to believe that the reverse may be true; i. e., the disease is certainly more serious during prolonged periods of abnormally dry weather, but may frequently develop suddenly and in destructive form as soon as such periods are broken by ample rainfall. Beal ('26) has also noted a greater prevalence of the disease during periods of dry weather. Therefore, since a study of the relation of moisture conditions to the occurrence of wilt did not strengthen the theory that the wilt may develop as the result of mechanical plugging of the vessels owing to increased growth of the fungus, it was desirable to study other factors which might be involved. This appeared essential, too, since microscopic examination of the vascular system of many cotton plants with typical wilt symptoms failed in many instances to reveal the presence of hyphal filaments in the vessels, and in others, when the fungus was detected, it was only in very meager amounts.

Some of the experiments of other investigators on the factors involved in wilting of plants by other Fusaria may be mentioned. Brandes ('19) found that cultures of *Fusarium cubense*, grown in Richards' solution, when filtered free from the fungus, produced a marked wilting in buckwheat and bean plants, as well as banana leaves. He obtained the same results using Uschinsky's solution as a medium, and concluded that in the disease known as banana wilt, wilting is not due to plugging of the vessels by mycelium, but is probably the result of toxic excretions by the fungus.

Bisby ('19) reports the results of experiments in which leaves

of different plants were placed in filtrates from *Fusarium oxysporum*, *F. discolor sulphureum*, *Fusarium* from pea, and other fungi. Wilting occurred within a few hours with some extracts, a fact which he interprets as not to be explained by changes in acidity. Excised leaves placed in uninoculated media and in water did not wilt until considerable time had elapsed. The injurious effect was also noted after boiling the filtrates and after diluting them considerably. He concludes that the wilting is not due to some poison which is specifically active against certain plants, since potato leaves wilt as readily in old *Rhizopus* solutions as in solutions in which *F. oxysporum* had grown.

Haskell ('19) states that from numerous microscopic observations of the stems of potato plants infected with *Fusarium oxysporum*, he found no instance of a stoppage of the tracheae sufficient to shut off the passage of sap.

In 1920, Young and Bennett ('21) made an effort to determine the method by which *Fusarium oxysporum* induces wilting of potato plants. They found that filtrates of this fungus growing upon Richards' solution were increasingly toxic to potato plants as the age of the cultures increased up to the fortieth day. Furthermore, with this increase in toxicity there was noted, after a 10-day period, a gradual decrease in hydrogen-ion concentration, from an initial reaction of P_H 5.0 to P_H 7.4 on the fortieth day. But when the control (uninoculated) solution was adjusted to P_H 7.4, there was no toxicity noted when cut stems were placed in it. From this it is concluded that the change in reaction, while not the primary cause of wilting, indicated the presence of a compound with a slightly alkaline reaction. Autoclaving or boiling did not alter the toxicity of this substance.

In 1921, Ajrekar and Bal ('21), of India, working on cotton wilt, were unable to obtain wilting of cotton plants by means of the alcoholic extract or by the method described by Hutchinson ('13). They did not, however, conclude from their very meager tests (only 2 plants were used) that no toxins were produced by the fungus; on the contrary, when they sectioned diseased plants and examined them microscopically the number of vessels which were not occupied by the fungus was so great in comparison with

the number occupied that they suspected the action of a toxic substance rather than a mechanical plugging up by fungus mycelium.

Other investigators who have attempted to determine the cause of wilting by various Fusaria or the nature of substances excreted by such parasitic fungi are Picado ('23), Fahmy ('23), Goss ('24), and others.

In the biennial report of the Director of the Kansas Agricultural Experiment Station (page 75) which appeared in 1924, it is recorded that *Fusarium Lycopersici* has been found to secrete an enzyme which, when precipitated, dried and re-dissolved in distilled water, will cause young plants to wilt rapidly when the cut stems are immersed in the solution. The toxicity of the enzyme is destroyed by boiling. Both residue and the dialysate of nutrient solutions upon which the fungus was grown produced wilting of young plants. From this it is concluded that two toxic substances exist, one a colloid and the other a crystalloid.

Quite recently, Rosen ('26) has shown that filtrates representing cultures growing on Richards' solution are quite toxic to cotton plants, while filtrates of cultures growing on media containing organic nitrogen, such as Uschinsky's asparagine solution or peptone-beef broth, are non-toxic. He raises the question if this might not explain why cotton wilt is more prevalent in light sandy soils devoid of appreciable quantities of organic nitrogen than in richer types of soils. By subjecting filtrates of the fungus grown on Richards' solution to distillation *in vacuo*, as well as to ordinary boiling and testing, the distillates and also the residues were found to possess toxic properties, the residue being considerably more toxic. The filtrates of 2- or 3-weeks-old cultures on Richards' solution gave positive tests for nitrites. These were found in quantities ranging from 0.012 mgm. to 0.04 mgm. of nitrogen for each cc. of solution. Using chemically pure sodium nitrite solution comparable to the concentration found in the filtrates, it was determined that this is markedly toxic to cotton plants. Microscopic observations of the vascular elements of wilted cotton plants by Rosen ('26) substantiate the findings of the writer and others that wilting is not due to mechanical plugging up of the vessels by the fungus. Rosen

records that in badly infested fields wilted cotton plants are found occasionally in whose vascular tissues the fungus may be apparently absent, and he suggests that the wilting and interior discoloration of the xylem in these cases is due to the formation of toxic substances by the fungus in the soil. This author concludes that the wilting of cotton infected with *Fusarium vasinfectum* is considered to be due to poisonous chemical substances formed by the fungus, and that filtrates of *Fusarium vasinfectum* growing on Richards' solution possess at least two substances poisonous to cotton. One is a volatile compound with an alkaline reaction and the other is an inorganic salt in the form of nitrite. It is evident from the above references and others not enumerated in this paper that in many of the Fusarium diseases, including those of banana, cotton, potato, and tomato, the theory of mechanical plugging of the fungus as being the factor responsible for wilting is no longer accepted. It is now suggested that toxic substances are probably responsible for wilt symptoms and related pathological phenomena.

EXPERIMENTS RELATING TO TOXIC ACTION BY THE FUNGUS

In order to obtain some information on the probable toxic properties of substances given off by *Fusarium vasinfectum*, the following experiment was performed. The fungus was grown at room temperature for 18 days in 150-cc. Erlenmeyer flasks on 50 cc. of Duggar's nutrient solution previously described, and treated as follows: In a series of 4 flasks, the mats were collected on filter paper by means of a Buchner suction filter, and the filtrates boiled for 10 minutes. Another series of 4 flasks was treated similarly but not boiled. In another series of 4 flasks, the mycelial mats were collected on filter paper as described above, ground with 20 grams of fine quartz sand for 15 minutes in a mortar, and the mixture extracted with 75 cc. of sterile distilled water. Another was prepared in the same way and the extract boiled for 10 minutes. A final series of filtrates was also prepared as described above, and the solution afterward diluted with sterile distilled water at the rate of 1 part filtrate to 3 parts of water. After cutting away the roots, cotton seedlings which had been sprouted in washed sand and which averaged 6 to 8 inches in

height were immersed in 2 of the flasks in each series. In the remaining 2 flasks of each series, the roots of the plants were left intact. Control flasks contained Duggar's nutrient solution and sterile distilled water. All series were placed in the greenhouse in bright light at a temperature of approximately 75–80° C., and examined at intervals of 3, 6½, and 36 hours. The data obtained are presented in table IV.

TABLE IV

EFFECT OF FILTRATES AND MYCELIAL EXTRACTS OF 18-DAY CULTURES OF FUSARIUM VASINFECTUM ON COTTON SEEDLINGS

Series No.	Treatment	Wilt symptoms present after		
		3 hr.	6½ hr.	36 hr.
		Filtrate		
1	Boiled	None	Positive	Very pronounced
1 a	Unboiled	None	Positive	Very pronounced
1 b*	Boiled	Slight	Positive	Very pronounced
1 c*	Unboiled	None	None	None
		Extract of mycelial mat		
2	Boiled	None	Positive	Very pronounced
2 a	Unboiled	None	None	Positive
2 b*	Boiled	None	Slight	Pronounced
2 c*	Unboiled	None	Slight	Very pronounced
		Filtrate†		
3	Boiled	None	None	Slight
3 a	Unboiled	None	Slight	Positive
3 b*	Boiled	None	None	None
3 c*	Unboiled	None	Slight	Positive
		Control		
4‡	Boiled	None	None	None
4 a‡	Unboiled	None	None	None
5 §	Boiled	None	None	None
5 a§	Unboiled	None	None	None

* Root removed at base of plants.
† Filtrate diluted 1 to 3.
‡ Duggar's nutrient solution.
§ Sterile distilled water.

From the data recorded, it is observed that both filtrates from the 18-day-old culture of the fungus and an extract made of the mycelial mat of the same age possess toxic properties. In the case of the filtrates, slight evidence of wilting was noticeable

at the end of 3 hours and became quite definite at the end of 6½ and 36 hours. In uninoculated controls of both Duggar's nutrient solution and sterile distilled water the seedlings remained healthy and turgid, even after 36 hours (pl. 32, figs. 2–3). The extracts made from the mycelial mats appear also to possess toxic properties in about the same degree as the filtrates (pl. 32, fig. 2). The seedlings whose roots had been cut away prior to immersing did not reveal wilt symptoms any more pronounced than those in which the roots were left intact. Diluting the filtrates in the ratio of 1 part filtrate to 3 parts of sterile distilled water appears to have lowered the toxicity to some extent, and in these series wilt symptoms became definite only after the maximum period of 36 hours. The toxic substance is approximately thermostable in both the filtrate and mycelial extract used in these experiments. The P_H of the nutrient solution prior to inoculating was 5.6, and at the end of the 18 days the filtrate was 6.8. Additional experiments are now in progress to ascertain if Rosen's ('26) results are correct concerning the presence of nitrites in filtrates of *Fusarium vasinfectum*.

PATHOGENICITY OF FUSARIUM VASINFECTUM ATK.

During the last few years different investigators have raised the question as to the real parasitic nature of the fungus *Fusarium vasinfectum* in connection with wilt of cotton. For instance, Ajrekar and Bal ('21), in their inoculation experiments, do not appear to have secured uniformly successful infection, and they suggested that such negative results perhaps may have been due to the fact that the season was far advanced when their experiments were carried out. They concluded from the result of their inoculation experiments that the Indian species of cotton wilt was not a virulent parasite.

In 1924 Dastur advanced the theory that cotton wilt is not due to the parasitic action of a species of *Fusarium*, but that it may be caused by the excessive accumulation of aluminium and iron salts within the tissues of the plants. He arrived at this conclusion because there was a constant accumulation of iron and aluminium compounds in the tissues of wilting plants and a constant absence of these compounds in the tissues of healthy

plants. He used qualitative microscopical tests for these metals. Tissues of plants which were infected with *Rhizoctonia Solani* Kühn were also examined for aluminium and iron compounds with negative results. Dastur also failed to isolate a parasitic organism from the wilting plants, and suggested that the accumulation of the above compounds may have some correlation with the wilt and that the species of *Fusarium* which had been isolated from wilting plants in different cotton tracts may be only a contributory factor in hastening the death of the plant and merely follows in the wake of the accumulations of these compounds in the tissues.

Dastur worked on varieties and selections of cotton listed as AK_2, AK_4, and Roseum. These were inoculated with different strains of *Fusarium* which had been isolated from wilted cotton plants. He used both virgin soil and sand in pots, and inoculations were made after scraping away the soil an inch or two deep around the plants; and the entire contents of agar tubes, in which the fungus was growing luxuriantly, were placed around the roots. The soil thus scraped away was then returned. In some pots the upper lateral roots were cut before introducing the fungus, but the tap roots were uninjured. His infection experiments were uniformly negative; the controls and inoculated plants were equally healthy and developed good flowers and bolls.

During the progress of this investigation, the writer has endeavored to substantiate the findings of Dastur with reference to the presence of iron and aluminium compounds in the tissues of cotton plants, particularly with plants showing typical wilt symptoms, such as stunted growth, yellowing of leaves, and pronounced vascular discoloration. On August 28, 1926, 3 Trice cotton plants with typical wilt symptoms and 3 healthy plants of the same variety were collected in a field of the Mississippi Experiment Station. These were referred to Dr. W. F. Hand, State Chemist, with a request that quantitative analyses be made for aluminium and iron oxides in the leaves, stems, and roots. By using official quantitative methods, the per cent of iron oxide was determined in the above parts of both healthy and diseased plants, but the results for aluminium were discarded

because of the probable inaccuracy of the present method for quantitative determinations of these compounds in the amounts occurring in cotton plant tissues. The per cent of iron oxide and total ash of the leaves, stems, and roots of healthy and diseased Trice cotton plants are given in table v.

TABLE V

QUANTITIES OF Fe_2O_3 FOUND IN TRICE COTTON PLANTS*

Healthy	Per cent	Diseased	Per cent
Total ash in leaves	14.32	Total ash in leaves	18.54
Iron oxide in leaves	0.028	Iron oxide in leaves	0.04
Total ash in stems	3.75	Total ash in stems	4.11
Iron oxide in stems	0.006	Iron oxide in stems	0.008
Total ash in roots	3.45	Total ash in roots	3.70
Iron oxide in roots	0.016	Iron oxide in roots	0.014
Total ash in plant	21.32	Total ash in plant	26.35
Iron oxide in plant	0.050	Iron oxide in plant	0.062

* Average of 3 plants

Additional Trice cotton plants in a more advanced stage of maturity were collected at the South Mississippi Experiment Station on September 8, and quantitative analyses made for iron oxide in the stems and roots. The results, however, were practically the same as those embodied in table v; i.e., the amount of iron oxide found in both healthy and wilt-infected plants was about the same. The above results do not indicate any close correlation between iron accumulations in the tissues of the plants and wilt infection. The writer has also made numerous qualitative tests for iron with healthy and wilt-infected cotton plants of approximately mature ages. For these tests, potassium acid thiocyanate solution was used, but no appreciable difference could be observed in the stems and roots of healthy and diseased tissues.

In order to test further Dastur's ('24) theory of aluminium and iron accumulations in the tissues of plants as a primary factor involved in producing wilt, another experiment bearing upon this question was planned. In the summer of 1926, a field was visited at the South Mississippi Station which was badly infested with wilt and which had been so for years previous. A quantity of soil from this field was collected and shipped to the laboratory for

some pot experiments. Eighteen pots were filled with the soil and half of them sterilized in the autoclave at 15 pounds pressure for 5 hours. The pots containing the sterile and unsterile soil were then planted with delinted Delfos 6102 cotton seed and placed in benches in the greenhouse, the date being September 15. It was considered that if the disease could be induced in the sterile pots in the absence of the fungus, some significance could be given the probable accumulative effect of certain compounds in the tissues of the plants. The plants were allowed to grow until December 3. Approximate readings were made on November 1, and more accurate readings made by cutting the stems of the plants for evidence of vascular discoloration, on December 3. The results obtained are shown in table VI.

TABLE VI

EXPERIMENTS TO DETERMINE THE PATHOGENICITY OF COTTON WILT, FUSARIUM VASINFECTUM ATK., IN THE GREENHOUSE. SEASON 1926—VARIETY DELFOS 6102

Pot No.	Soil treatment	Number infected plants	
		Apparent wilt Nov. 1	Actual wilt Dec. 3
1	Unsterile	2	3
1A	Sterilized	0	0
2	Unsterile	2	1
2A	Sterilized	0*	0
3	Unsterile	1	2
3A	Sterilized	0†	0
4	Unsterile	2	6
4A	Sterilized	0	0
5	Unsterile	4‡	5
5A	Sterilized	4	0
6	Unsterile	0	1
6A	Sterilized	0	0§
7	Unsterile	8	8
7A	Sterilized	0	0
8	Unsterile	0	8
8A	Sterilized	0	0
9	Unsterile	0	2
9A	Sterilized	0	0

* 2 dead with *Rhizoctonia.*

† 1 dead with *Rhizoctonia.*

‡ 3 killed by *Fusarium vasinfectum.*

§ All infected with *Rhizoctonia.*

The results obtained in the above experiment indicate very clearly that the strain of *Fusarium vasinfectum* present in the soil obtained from the infested field at the South Mississippi

Station was pathogenic and quite virulent, since infection occurred in all of the pots which were not sterilized, and in some cases all of the plants (8 in number) were infected when the plants were taken down and the experiment terminated (pl. 32, fig. 1).

It is quite likely that the failure of Dastur ('24) to secure infection as the result of his inoculations was due to the method he employed. The writer has also frequently found it difficult to infect plants under greenhouse conditions in sand cultures particularly, even after an interval of 90 days, if the fungus is placed merely around the roots of the seedlings. Such a method is not as reliable as that of mixing the fungus thoroughly with the soil or sand prior to sowing the seed. From these and other infection experiments it would seem that cotton wilt cannot be attributed to the accumulation of certain compounds within the tissues, such as aluminium and iron, but that the fungus is responsible for the disease and the attendant symptoms. The recent work of Butler ('26) substantiates this view.

Although the above experiments do not indicate any relation between cotton wilt and the accumulation of iron or aluminium within the tissues of the plants, it is interesting to note the results which Hoffer ('23) has obtained bearing upon this question as it relates to corn root-rot. He has found that in the presence of soluble iron and aluminium salts in the soil or in the presence of other growth-inhibiting factors corn exhibits an abnormal accumulation of these elements in the vascular plate tissues in the nodes of the stalk. There is also some concentration in the leaf tissues. Conditions result which retard the translocation of food to the roots. The roots later cease to function and accordingly their vitality is greatly impaired. He has contributed some very definite data on this point. The most severe cases of root-rot with which he has come in contact were found in soils notable for their deficiencies of lime and phosphate. Potash deficiencies were also often noted. His experiments indicate that root-rot is not due to fungi (as the primary factor), but that these organisms are usually associated with and involved in the crop failure.

In some later experiments ('23), Hoffer and Trost have added materially to the above. A set of acid soils was treated in a manner to increase or decrease the aluminium absorbed by the

plant and to determine the intensity with which soil organisms would attack plants under the conditions. These experiments showed that both lime and phosphate lowered the assimilation of aluminium. The roots of all plants showed rot lesions caused by *Fusarium moniliforme*, but the severity of the damage was modified by the soil treatment and was serious only in the presence of aluminium salts and deficiencies of lime and phosphates. Hoffer also determined the relation of aluminium salts to the susceptibility to root-rot or the invasion by one of the root-rot fungi. In these experiments he used *Gibberella saubinetti*. The results showed that in the presence of aluminium salts there was a predisposition of the plant to invasion by the fungus. A potash reserve in the plant increases the resistance by lessening markedly the accumulations of iron and aluminium in the nodal joints.

In this connection, McGeorge ('25) has also recently found that aluminium is a factor directly associated with the retarded growth of sugar-cane on the acid mauka lands in Hawaii, and further he has found abnormal accumulations of aluminium and iron at the nodes of certain varieties of cane. In the case of these highly acid soils, he considers the retarded growth of the sugar-cane as a direct toxic action of aluminium and not a phosphate deficiency.

ADDITIONAL EXPERIMENTS BEARING UPON ALUMINIUM TOXICITY OF COTTON AND COTTON WILT

Because of the interest manifested regarding the probable absorption of soluble aluminium salts in certain soils and predisposing such plants as corn and perhaps sugar-cane to invasion by soil-inhibiting organisms, it was of interest to study further the rôle that such compounds might play in predisposing cotton plants to infection by *Fusarium vasinfectum*. Accordingly, 2 series of water cultures in battery jars containing aluminium salts in varying concentrations were prepared. Shive's ('16) R_2C_5 nutrient solution was used for this purpose and the aluminium was supplied in the form of the chloride and the sulphate, and added to the nutrient solution to give the following normalities. All treatments were made in duplicate:

SERIES I

	p.p.mil. Al.
1. Control, basic nutrient only	None
2. Basic nutrient plus aluminium sulphate to make N/2500	3.6
3. Basic nutrient plus aluminium sulphate to make N/1000	9
4. Basic nutrient plus aluminium sulphate to make N/500	18
5. Basic nutrient plus aluminium sulphate to make N/250	36

SERIES II

	p.p. mil. Al.
1. Control, basic nutrient only	None
2. Basic nutrient plus aluminium chloride to make N/2500	3.6
3. Basic nutrient plus aluminium chloride to make N/1000	9
4. Basic nutrient plus aluminium chloride to make N/500	18
5. Basic nutrient plus aluminium chloride to make N/250	36

Delfos 6102 cotton seedlings, the seed of which had been previously delinted with sulphuric acid and sprouted in washed sand, were used in these cultures. Twelve seedlings, supported by galvanized wire of a suitable mesh, were placed in each jar when the radicles were about 4 inches long and allowed to grow in the nutrient solutions for 29 days. The solutions were changed in the jars regularly once a week and precaution taken to prevent any contamination with algal forms, etc.

On comparison of the cultures from time to time, toxicity was scarcely apparent in either the series containing the aluminium sulphate or aluminium chloride until a concentration of N/250 (36 p.p. mil. aluminium) was reached. In these cultures, represented in each series by number 5, some toxicity was apparent, not only as related to height of the seedlings, but as to the root development which was also considerably retarded. The effect of these salts when added to the nutrient solution is best indicated by the photographs in pl. 33, figs. 1–2. At the end of the 29-day growth period, the lengths of the tops of the plants were measured and notes made on the condition of the roots. These data are summarized in table VII.

Of the two salts used, the aluminium chloride appears to be slightly more toxic to cotton under the conditions of the above experiment, especially the N/500 and N/250 concentrations.

TABLE VII

RELATIVE LENGTH OF COTTON SEEDLINGS GROWN IN VARYING AMOUNTS OF ALUMINIUM SULPHATE AND ALUMINIUM CHLORIDE FOR 29 DAYS

Culture	Length of tops inches		Condition of roots	
	Sulphate	Chloride	Sulphate	Chloride
Control	11.5	12	Good—normal	Good—normal
N/2500	12.0	10	Good—normal	Good—normal
N/1000	10	9.5	Good—normal	Good—normal
N/500	12	10.5	Good—normal	Fair—few laterals
N/250	8.4	7.8	Fair—few laterals	Poor—very few laterals

After the length of plants in the above experiment had been determined they were put back into the battery jars and to each was added freshly prepared Shive's R_2C_5 nutrient solution. Each culture was then immediately inoculated with a spore suspension of *Fusarium vasinfectum*, in order to ascertain whether the plants which had received varying amounts of aluminium sulphate and chloride would reveal any decided differences to invasion of the fungus as compared with the control plants or the ones which had received the basic nutrient solutions only. At the end of one week after inoculation, all cultures were infected with the fungus (pl. 33, fig. 3) and so far as could be observed, the control plants were equally susceptible to attack by the fungus.

Judging from the above experiment, it seems that aluminium sulphate and aluminium chloride are not appreciably toxic to cotton plants in concentrations lower than 36 parts per million. Moreover, it is believed by the writer, too, that such a concentration of soluble salts of aluminium does not occur in soils of cotton tracts generally in the southern states, and that this factor is perhaps of little consequence in predisposing plants to infection by *Fusarium vasinfectum* as has been supposed by Dastur ('24).

EFFECT OF NUTRITION UPON THE DEVELOPMENT OF COTTON WILT

Greenhouse experiments.—In studying the effects of varying conditions of nutrition upon the development of wilt of cotton, a nutrient solution recommended by Hartwell and Pember ('15) was used as a basic nutrient. This nutrient had the following composition:

.2N Ca $(NO_3)_2.4H_2O$	15 cc. per litre
.1N NH_4NO_3	10 cc. per litre
.1N KCl	8 cc. per litre
.2N $MgSO_4.7H_2O$	8 cc. per litre
8.3 grams per litre $CaH_4(PO_4)_2$	1 cc. per litre
$FePO_4$	Trace

Stock solutions of the salts in the above concentrations were prepared in 3-litre bottles and 12 similar bottles were used for the desired dilutions for the different series of treatments.

The series of treatments used were as follows:

Series I—Basic nutrient only.

Series II—Same as I but with phosphorus omitted.

Series III—Same as I but with phosphorus increased 20 times.

Series IV—Same as I but with potassium omitted.

Series V—Same as I but with potassium increased 10 times.

Series VI—Same as I but with potassium increased 20 times.

Series VII—Same as I but containing 1/10 less nitrogen.

Series VIII—Same as I but with nitrogen increased 2 times.

Series IX—Same as I but with calcium omitted.

Series X—Same as I plus 24 p.p.m. iron from ferric ammonium sulphate.

Series XI—Same as I plus 54 p.p.m. iron from ferric ammonium sulphate.

Series XII—Same as I plus 12 p.p.m. aluminium from potassium aluminium sulphate.

Equivalent concentrations of $NaNO_3$, Na_2HPO_4 were used in the above Hartwell and Pember nutrient solution when calcium was omitted from the treatment, and likewise an equivalent of NaCl was employed in the treatments which did not receive potassium.

Three-gallon glazed pots containing washed sand were used for growing the plants, and each series of treatments contained 4 pots. The experiment was begun on August 9, 1926, and on this date each pot of the different series of treatments was planted with delinted seed of Delfos 6102, a staple cotton which is quite susceptible to wilt. After the seedlings were a few days old, they were thinned to 6 plants in each pot. During the first

6 weeks of growth, each series of cultures was given 300 cc. per pot of the nutrient once a week, and after 3 such weekly applications each pot was washed out thoroughly with one gallon of distilled water to prevent the possibility of excess salt accumulation. After 6 weeks had elapsed and the plants became larger they were given 300 cc. of the nutrients per pot every 10 days, and after each pot had received 3 such consecutive 10-day treatments they were washed out with the distilled water as indicated above. On September 9, when the plants were a month old, all series were inoculated with *Fusarium vasinfectum* by applying the entire contents of a bean-agar test-tube culture of the fungus to the roots of the plants. On October 5, all plants in each series were again inoculated by applying to the roots the mat of the fungus which had grown on 50 cc. of Duggar's solution for 10 days. A final inoculation was made on October 20, bits of diseased stems of mature Delfos 6102 cotton plants from a wilt-infested field being placed around the roots of the plants. The schedule of treatments given above was followed as closely as possible, but no attempt was made to keep the pots at a constant soil moisture. Moisture determinations were made, however, with untreated control pots until the plants died of starvation, and these results indicated that the moisture content in the treated pots was approximately 25 per cent of the water-holding capacity of the sand.

Very few of the plants in any of the series of treatments were killed by the wilt, but on March 5, after an interval of almost 7 months, the different series of treatments were terminated and examinations of the plants made as to their green weight, dry weight, vascular discoloration, lateral root discoloration, and the number of plants showing positive infection. Evidence of positively wilt-infected plants was recorded only when such a symptom as pronounced vascular discoloration was obtained by splitting the plants with a stainless steel knife. The numbers with lateral root discoloration were recorded, and undoubtedly, if these plants had been cultured, *Fusarium vasinfectum* could probably have been isolated, though time would not permit such cultural tests for evidence of the fungus. The results obtained in these nutrition experiments are presented in table VIII.

TABLE VIII

EFFECT OF NUTRITION UPON THE DEVELOPMENT OF COTTON WILT IN THE GREENHOUSE—SEASON 1926

Series No.*	Pot No.	Green wt. of plants, gms.			Av. ht. of plants cm.	Dry wt. per series gms.	Vigor	Vascular discoloration			Number wilt-infected plants			Number plants with lateral root discolorations		
		Each	Per series					Each	Per series		Each	Per series		Each	Per series	
			Av.	Total					Av.	Total		Av.	Total		Av.	Total
I Basic nutrient solution	1	50.5			34		Good	0			0			0		
	2	76			34		Good	0			0			0		
	3	58.5			30		Fair	0			0			6		
	4	62	61.5	247	35	79.8	Fair	1†	.25	1	1	.25	1	0	1.5	6
II Phosphorus omitted	1	67			35		Good	0			0			6		
	2	65			31		Fair	4‡			3			4		
	3	64.5			32		Fair	0			0			6		
	4	70	67	266.5	31	82.5	Fair	0	1	4	0	.75	3	0	4	16
III Phosphorus increased × 20	1	64.6			39		Good	1			1			2		
	2	88.5			36		Good	2			2			6		
	3	110			42		Very good	1			1			2		
	4	67	82.5	330.1	33	92.4	Fair	1	1.25	5	1	1.25	5	3	3.25	13
IV Potassium omitted	1	87			31		Fair+	1			1			3		
	2	74			30		Fair	0			0			6		
	3	68.5			34		Fair	1			1			6		
	4	93	85.6	322.5	33	84.9	Fair	3	1.25	5	3	1.25	5	4	4.75	19

TABLE VIII (Continued)

Series No.*	Pot No.	Green wt. of plants, gms. Each	Green wt. Per series Av.	Green wt. Per series Total	Av. ht. of plants cm.	Dry wt. per series gms.	Vigor	Vascular discoloration Each	Vascular Per series Av.	Vascular Per series Total	Number wilt-infected plants Each	Wilt Per series Av.	Wilt Per series Total	Number plants with lateral root discolorations Each	Lateral Per series Av.	Lateral Per series Total
V Potassium increased × 10	1	71			33		Fair	1			1			2		
	2	84.5			34		Fair +	1			1			1		
	3	78			31		Good	0			0			0		
	4	68	75.4	301.5	32	78	Good	0	.5	2	0	.5	2	0	.75	3
VI Potassium increased × 20	1	67			33		Good	1			1			0		
	2	80			32		Good	0			0			0		
	3	63			30		Fair	1			1			0		
	4	68	69.5	278	31	73.1	Good	0	.5	2	0	.5	2	1	.25	1
VII 1/10 less nitrogen	1	88			35		Fair−	3			3			3		
	2	67			36		Fair	3			3			4		
	3	63			27.5		Fair	2†			3			6		
	4	73	72.7	291	31.5	84.6	Fair	0	2	8	0	2.25	9	0	3.25	13
VIII Nitrogen increased × 2	1	71			32.5		Fair	2			2			6		
	2	83			38		Good	0			0			0		
	3	58			32		Fair	0			0			6		
	4	74	66.5	286	35.5	72.9	Fair	0	.5	2	0	.5	2	0	3	12
IX Calcium omitted	1	110			47		Very good	0			0			0		
	2	114			46		Very good	1			1			1		
	3	130			56		Very good	2			2			2		
	4	131	121	485	53.5	124.1	Very good	0	.75	3	0	.75	3	0	.75	3

TABLE VIII (Continued)

Series No. *	Pot No.	Green wt. of plants, gms.			Av. ht. of plants cm.	Dry wt. per series gms.	Vigor	Vascular discoloration			Number wilt-infected plants			Number plants with lateral root discolorations		
		Each	Per series					Each	Per series		Each	Per series		Each	Per series	
			Av.	Total					Av.	Total		Av.	Total		Av.	Total
X 24 p.p. m. iron§	1	64.5			27		Fair	4			4			3		
	2	72			34		Poor	1			1			4		
	3	56.5			29		Poor	5			5			6		
	4	84	69	277	33	71.4	Fair	4	3.5	14	4	3.5	14	6	4.75	19
XI 54 p.p. m. iron	1	67			27.5		Poor	1			1			6		
	2	78			28		Poor	2			2			2		
	3	86			30		Fair	6			6			6		
	4	97	82	328	35	77.7	Poor	2	2.75	11	2	2.75	11	6	5	20
XII 12 p.p. m. aluminium‖	1	98			34.5		Fair	0			0			1		
	2	100			35.5		Fair	2			2			2		
	3	67			29		Poor	2			2			4		
	4	87	88	352	35	94.2	Fair	3	1.75	7	3	1.75	7	3	2.5	10

* All series contain Hartwell & Pember's basic nutrient solution.

† Slight at base of tap root.

‡ 3 plants with heavy discoloration, 1 plant killed.

§ Iron was supplied from ferric ammonium sulphate.

‖ Aluminium was supplied from potassium aluminium sulphate.

The plants in the pots of each series were photographed on the day the experiment was completed, and they are shown in pls. 34–35.

An examination of the data recorded in table VIII reveals some interesting facts with reference to the nutrition of cotton and the probable rôle it may play in increasing or lowering the resistance of the plant to invasion by *Fusarium vasinfectum*. So far as the writer is aware, no previous attempt has been made to study these questions with respect to cotton and their relation to the development of wilt under greenhouse conditions. It was observed that the disease developed in all of the series of treatments. It was less in series I, which received the basic nutrient without any variation of its nitrogen, potassium, phosphorus, or iron content. As evidenced by the vascular discoloration of stems and tap roots, the infection was highest in series X and XI, containing respectively 24 and 54 parts per million iron from ferric ammonium sulphate. Next in number of wilt-infected plants was series VII, containing 1/10 less nitrogen, series XII, with 12 parts per million aluminium from potassium aluminium sulphate, and series IV, in which potassium was omitted. The pots in which the potassium content was increased were notably free of the disease, as indicated by the lack of vascular discoloration in both stems and roots and the absence of lateral root discoloration. The same is decidedly true of series IX, in which calcium was omitted. In the pots which received marked increases of phosphorus and nitrogen the number of plants with vascular discoloration was low, but the lateral root discoloration was somewhat high.

As revealed by the dry and green weights, the plants in the pots from which calcium was omitted made the most vigorous growth. This was very noticeable as compared with the other series. No toxicity developed in series XII, which received the basic nutrient plus 12 parts per million aluminium salt, and the growth of these plants was good despite the fact that the examination of the roots revealed 7 infected plants and several with lateral root discoloration.

The data as presented do not show any consistent diminution or increase of infections by the various treatments with the exception of the ones receiving increased potassium, the ones from which calcium was omitted, and those in which the iron content

was high. The infection as evidenced by vascular discoloration of stems and roots was low in the pots receiving twice the amount of nitrogen, but, on the other hand, the lateral root discoloration in this series was high, and the fact that the green and dry weight was only a little better than series I (control pots) does not indicate any marked effect as the result of increasing nitrates in the nutrient. The same may be said of increased phosphate in these treatments. Increased potassium content appears to have increased resistance to the fungus, but these plants did not make any better growth, as judged by the dry weight, than did the plants in series IV, in which potassium was omitted. The specific rôle that potash may play in increasing resistance in cotton to invasion by a fungus like that causing wilt is unknown. We know that it is important in the translocation of food materials within plants, and, as Hoffer ('23) suggests in the case of corn, it may also be of importance in the maintenance and normal functioning of the vascular elements of cotton.

On studying the behavior of the plants in the series with high iron content, we find the infection is somewhat high, and this would lend support to Dastur's ('24) theory of iron accumulation as being a predisposing factor to invasion by the fungus. However, this fact is not borne out by quantitative analyses of the tissues of diseased and healthy plants nor by inoculation experiments, as referred to previously in this paper. Because of the pressure of other work, analyses of the ash of the plants in these experiments were not made, but additional nutrition experiments are in progress and this point will receive attention.

The effect of commercial fertilizers upon cotton-wilt infection has also been studied to some extent under greenhouse conditions. On February 3, 1926, duplicate sand cultures were prepared in 10-quart galvanized zinc buckets, each of which had been equipped with special aerating equipment in the form of 2 galvanized zinc tubes attached to the opposite ends of an inverted trough. The sides of the trough supporting the tubes were cut "tooth-like" to facilitate percolation of water when introduced into the buckets. The tubes were also, of course, hollow and when placed in the buckets prior to filling the latter with sand, permitted the plants to be sub-irrigated; at the same

time this facilitated evaporation from the bottom. Approximately 8 kilograms of sand were used in each bucket and the fertilizer was used at the rate of about 800 pounds per acre, regarding 2,000,000 pounds of soil six inches deep as representing approximately one acre. This is in accordance with the usual fertilizer practice in pots when computing on an acre basis.[1] In these experiments, Mississippi Station Trice cotton was used, and the seed delinted with sulphuric acid before planting.

The sand in one of the buckets of each treatment was mixed thoroughly with a bean-agar culture of *Fusarium vasinfectum* and the other left uninoculated as a control. The plants were allowed to grow for 60 days, and then data recorded as to relative height of plants, vigor, and the number infected as evidenced by yellowing of leaves, vascular discoloration, etc. The results are shown in table IX.

TABLE IX

EFFECT OF COMMERCIAL FERTILIZER UPON THE DEVELOPMENT OF COTTON WILT IN THE GREENHOUSE. RATE OF APPLICATION 800 POUNDS PER ACRE. SEASON 1926

Fertilizer formula	Relative height of plants, inches	Vigor	No. plants	Infected plants after 60 days	
				Number	Per cent
8-4-0 check	9.5	Good	8	0	0
8-4-0	10.0	Good	8	3	37.5
8-4-4 check	11.5	Good	8	0	0
8-4-4	10.5	Good	8	0	0
8-0-4 check	9	Good	8	0	0
8-0-4	8.5	Good	8	5	62.5
0-4-4 check	8.5	Fair	8	0	0
0-4-4	8	Fair	8	4	50
12-4-4 check	12	Good	8	0	0
12-4-4	11	Good	8	0	0

From the above results, it appears that potash, when used at the above rate, may have increased the resistance of the plants to infection by the fungus. The results obtained are best indicated in pl. 36, fig. 1.

In other experiments of this nature, the potash in the formula was increased to 6 per cent and the mixture applied at the rate of 600 pounds per acre. However, at the end of 60 days, when the experiment was terminated, no appreciable difference in the

[1] From information supplied the writer by Dr. Oswald Schreiner, of the Bureau of Plant Industry, U. S. Dept. Agr.

amount of infection was noted between plants receiving potash and those to which none was added.

CONTROL

Field experiments.—Field experiments to determine the effects of commercial fertilizers upon the control of wilt were conducted during the season of 1926 at 2 localities in Mississippi. One set of experiments was located at the Central Experiment Station, A. & M. College, and another at the Poplarville Branch Experiment Station. The soil in the experimental plots at the Central Station was artificially inoculated, whereas the field used for recording infection data at the Poplarville Branch Station was already infested with wilt and the plots had been fertilized in the same manner for a period of 5 consecutive years. The size of the plots in the fertilizer treatments at the Central Station was approximately 1/40 of an acre, and at Poplarville approximately 1/12 of an acre.

TABLE X

COTTON WILT OCCURRING IN LONE STAR 65 VARIETY. FERTILIZER TREATMENTS AT CENTRAL STATION. SEASON 1926

Fertilizer formula	Rate per acre lbs.	Yield seed cotton per acre lbs.	Total number plants		% infection		
			in area* inoculated once	in area† inoculated twice	in area inoculated once	in area inoculated twice	Total
Check	——	140	219	42	3.50	5.56	9.06
8-4-8	600	712	288	63	2.20	3.17	5.37
8-4-4	600	572	267	59	3.87	7.35	11.22
8-4-0	600	260	264	61	4.16	5.47	9.63
Check	——	128	258	55	3.49	6.67	10.16
8-8-4	600	684	268	65	3.61	4.30	7.91
8-6-4	600	512	251	54	4.25	6.18	10.43
8-0-4	600	492	227	52	5.00	7.06	12.06
Check	——	140	261	51	3.96	1.98	5.94
6-4-4	600	536	279	59	4.66	8.49	13.15
4-4-4	600	496	296	64	4.28	7.81	12.09
10-5-5	600	708	267	56	3.74	4.80	8.54
Check	——	208	257	55	4.41	4.85	9.26
8-4-4‡	600	652	223	42	4.50	6.76	11.26
8-4-4	900	724	273	53	4.03	7.55	11.58
8-4-4	1200	804	254	54	2.37	2.48	4.85
Check	——	152	226	47	3.70	5.00	8.70

* Soil inoculated May 4 by plowing under re-inoculated sterilized oats.

† Soil inoculated again August 9 by pouring 100 cc. of spore suspension of *Fusarium vasinfectum* around roots of plants.

‡ Lime applied at rate of 4500 pounds per acre, to approximately neutralize soil.

The plots at the Central Station were seeded to Lone Star 65 cotton early in May, and in due time the total number of plants and the percentage of infections were determined. Yield records were obtained in October. These records are given in table x, and represent the average of 3 replications of the one-fortieth-acre plots. The results on infection counts are given in 2 areas in each treatment, one being inoculated just before planting time, the other being a section of the row of each plot which was re-inoculated with 100 cc. of a spore suspension of the fungus in August. The results obtained in a single season at the Central Station on artificially inoculated soil are decidedly inconsistent, and it was only where very heavy rates of fertilizer (1200 pounds per acre) were used that the infection was materially reduced. The addition of lime at the rate of 4500 pounds per acre had no effect in reducing wilt.

The arrangement of plots and the fertilizers used at the Poplarville Branch Station are indicated in table xi.

TABLE XI

ARRANGEMENT OF PLOTS AND AMOUNTS OF FERTILIZERS USED ON COTTON SOIL INFESTED WITH THE WILT FUNGUS, FUSARIUM VASINFECTUM. POPLARVILLE BRANCH STATION. PERIOD OF TREATMENTS 5 YEARS

Plot 3 400 lbs. acid phosphate 150 lbs. ammonium sulphate 50 lbs. potassium sulphate	*Plot 6* 400 lbs. acid phosphate 150 lbs. ammonium sulphate 100 lbs. potassium sulphate	*Plot 9* 150 lbs. ammonium sulphate 100 lbs. potassium sulphate	*Plot 12* 400 lbs. acid phosphate 300 lbs. ammonium sulphate 250 lbs. potassium sulphate
Plot 2 Check	*Plot 5* Check	*Plot 8* Check	*Plot 11* Check
Plot 1 400 lbs. acid phosphate 150 lbs. ammonium sulphate	*Plot 4* 400 lbs. acid phosphate 150 lbs. ammonium sulphate 100 lbs. potassium sulphate	*Plot 7* 200 lbs. acid phosphate 150 lbs. ammonium sulphate 200 lbs. potassium sulphate	*Plot 10* 400 lbs. acid phosphate 100 lbs. potassium sulphate

The plots at the Poplarville Branch Station were planted about the middle of April to Mississippi Station Trice cotton, and on September 2 wilt infection counts made in each plot. The data obtained are presented in table xii.

TABLE XII

OCCURRENCE OF COTTON WILT IN FERTILIZER PLOTS AT POPLARVILLE BRANCH EXPERIMENT STATION. SEASON 1926

Plot No.	Seed cotton per acre, lbs.	Total number plants	Number wilted	Per cent wilted
1	666	493	226	45.84
2	468	622	138	22.19
3	1206	691	102	14.76
4	1278	773	8	1.04
5	648	810	18	2.22
6	1080	762	7	.92
7	1080	660	8	1.21
8	216	612	17	2.78
9	630	665	1	.15
10	486	613	0	0
11	72	512	1	.19
12	990	590	0	0

The results with the above fertilizer treatments indicate that applications of potassium may have been beneficial in reducing the amount of wilt infection. In plot 1, which received adequate phosphate and nitrogen as ammonium sulphate, but no potassium, the infection was even considerably higher than the untreated plots. This is probably explained by the fact that these plants made a very vigorous growth last season owing to the liberal amounts of phosphate and nitrogen used, and such applications may have exhausted the potash reserve in this plot, resulting in a greater prevalence of the disease. At any rate, the writer observed the plants in plot 1 early in July and they were at the time quite large, with wilt beginning to appear over the entire plot. Photographs of the condition of the plants in plots 1, 4, 5, 6, and 12 were made on September 2, also on October 3, when they were maturing. These are shown in pls. 37–39. The spotted areas in plot 1 are especially noticeable, these being due to plants killed early in the season by the wilt organism. It is regrettable that there were not available more plots which had not received potash for a similar period; and until a larger number of such treatments have been made it cannot be definitely stated that the disease may be kept in check by such field fertilizer treatments. A field of Delfos 6102 cotton as shown was photographed by the writer on August 11, 1926 (pl. 38, fig. 2). This field had been planted to cotton for several years and had developed considerable wilt. At the suggestion of the County Agent,

the grower fertilized the crop with 700 pounds per acre of an 8–4–4 fertilizer and left a small portion of the field untreated as a check. Wilt infection counts were made in this field in August and the fertilized portion developed 4.5 per cent wilt, whereas the per cent of infected plants in the unfertilized portion was 26.8 per cent.

It is hoped that the enlarged program of field experimentation which has been inaugurated during the present season of 1927 in Mississippi with reference to the value of fertilizer applications in reducing wilt damage will yield further results.

Field Tests of Wilt Resistance

Tests of wilt resistance have been carried forward for a period of years in cooperation with the Department of Plant Breeding of the Mississippi Experiment Station. These experiments were made on soil which had been artificially inoculated with *Fusarium vasinfectum*. All of the varieties received 600 pounds per acre of an 8–6–4 fertilizer. The total money value per acre of each variety is estimated at twenty-four dollars for cotton seed and average lint prices for middling grade of the indicated length. These lint prices were obtained by averaging quotations of November 1, received from 5 southern market centers. The data obtained in these tests on 19 varieties of cotton for the season of 1926 are summarized in table XIII and were prepared by the Department of Plant Breeding of the Mississippi Experiment Station.

The results indicate that the most promising wilt-resistant staple cottons are Lightning Express, Watson, and Super Seven. Salsbury, another staple cotton, although not included in the experiment in 1926, is somewhat resistant as indicated by experiments made in former years. Rhyne's Cook, Dixie Triumph, Cleveland 54, and Solomon and Oates' Big Boll are promising wilt-tolerant, short-staple varieties. It will be observed that Trice ranked fifth in money value in this experiment. This variety matures its fruit early and rapidly. Frequently, such cottons, even though highly susceptible to wilt, are able to mature a good crop of bolls, especially when the plants are heavily fertilized and the season for growth is favorable.

TABLE XIII

TESTS OF WILT-RESISTANCE AT MISSISSIPPI EXPERIMENT STATION. SEASON 1926

Variety	Pounds per acre		Lint data			Total dollars per acre	Rank in value
	Seed cotton	Lint	Per cent	Length inches	Cents per lb.		
Trice Mississippi Sta.	891	272.6	30.6	1 1/16	13.37	43.87	5
Half & Half, Mahon	534	205.6	38.5	7/8	11.48	27.54	19
Cook, Rhyne	762	287.1	36.5	15/16	12.03	39.27	9
Cook, 307–6	654	228.9	35.0	7/8 f	11.67	31.81	16
Toole, Mathis	741	263.1	35.5	15/16 f	12.37	38.28	11
Toole, Perry	753	255.3	33.9	15/16	12.03	36.68	13
Cleveland, Pied.	903	293.5	32.5	15/16 f	12.37	43.62	6
Cleveland, Humco 20	657	231.9	35.3	15/16	12.03	33.00	15
Cleveland 54	828	278.2	33.6	1	12.70	41.93	7
Super Seven	888	291.3	32.8	1 1/8	14.53	49.49	2
Dixie Triumph	888	293.9	33.1	1	12.70	44.46	4
Kelly Big Boll	660	236.3	35.8	1 f	12.95	35.68	14
Sol. & Oates Big Boll	531	188.0	35.4	1 1/16 f	13.78	30.03	17
Miller	528	178.5	33.8	1 1/16	13.37	28.06	18
D. & P. L. No. 4	669	244.9	36.6	1 1/16	13.37	37.83	12
D. & P. L. No. 5	600	192.0	32.0	1 3/16 f	17.53	38.56	10
Watson	822	259.8	31.6	1 3/16	16.53	49.69	1
Lightning Express	846	256.3	30.3	1 3/16	16.53	49.45	3
Delfos 6102	771	241.3	31.3	1 1/8	14.53	41.42	8

Summary

1. The disease of cotton known as wilt has been further studied and described. An attempt has been made to present a complete discussion of the literature pertaining to the subject.

2. The disease is widely distributed in the Southern States, and the annual loss to the cotton crop in the United States is in excess of 350,000 bales. Such loss varies from year to year, and the amount of it depends somewhat on environmental factors.

3. The disease causes a yellowing of the leaves of the cotton plant accompanied by a stunted appearance of the main stems, usually rather early in the season. Under certain conditions new outbreaks occur at intervals throughout the growing season. The characteristic internal symptom, as in the case of other wilt diseases, is the discoloration of the fibro-vascular tissues of roots, stems, and occasionally leaf petioles. The fungus responsible for the occurrence of the disease is *Fusarium vasinfectum* Atk. Some of the morphological and cultural characters of the fungus are given. The fungus is placed in the recognized generic subdivision "Elegans." This species produces readily (in culture)

micro- and macro-conidia and chlamydospores. The latter are formed in corn-meal or potato-dextrose agar cultures in less than 3 weeks. The color of the stroma is marked and the acid effect well emphasized. The aromatic odor of the fungus when grown on rice is pronounced.

5. Physiological studies of the fungus have been made. These include growth-temperature relations of the fungus in pure cultures, hydrogen-ion relations, and a study of the factors involved in producing wilt. The fungus grows slowly at temperatures below 10° C., the optimum temperatures being 28-30° C., and the maximum temperature about 38° C. It grows well over a rather wide range of hydrogen-ion concentrations. The best growth occurred in cultures represented by P_H values of 3.0, 4.0, 4.5, and 5.5. The maximum growth occurred in cultures started at P_H 3.5. The fungus tolerates a culture solution strongly acid. The growth in the more acid cultures was slow in the beginning, but later more rapid, reaching a maximum growth rate almost as high as in the other series initially less acid. Change in reaction of the culture solution occurred during growth. Cultures originally acid became less so, while those originally alkaline became slightly acid, except the ones started on the extreme alkaline side. As the weight of mat increased, sugar disappeared from the culture solution.

6. The literature on the factors involved in producing wilt in the case of several Fusarium diseases, including cotton wilt, is reviewed, and experiments relating to toxic action induced by the cotton wilt fungus, *Fusarium vasinfectum*, have been performed. Both filtrates and extracts of the mycelial mat of the fungus possess toxic properties. These toxic substances are not destroyed by boiling, but diluting the filtrate lowers its toxicity.

7. Quantitative analyses for iron oxide, in the tissues of mature, healthy, and diseased cotton plants, exhibit no correlation between iron accumulation in the tissues and wilt infection. The pathogenicity of the fungus has been established under certain conditions in the greenhouse.

8. The toxicity of aluminium salts to cotton seedlings is not pronounced, and the susceptibility to invasion by *Fusarium vasinfectum* was no more evident in plants subjected to different

strengths of these salts in a nutrient solution for a certain period than in those grown in the absence of these salts.

9. The effect of nutrition upon the development of the disease in the greenhouse does not indicate any consistent lowering or increase of infection by the various treatments used. Exceptions are noted in the case of certain pot experiments with potassium, calcium, and those receiving additional iron. The most vigorous plants, as evidenced by their green weight, were those in which no additional calcium was added. Increasing the nitrate and phosphate content did not decrease the tendency of these plants to become infected, as evidenced by lateral root discoloration, although the vascular discoloration of the stem revealed by these plants was low. Infection was highest in the series of pots with added iron, but, as previously indicated, quantitative analyses of diseased and healthy tissues do not indicate a correlation between iron oxide content of the tissues and a tendency to become infected when inoculated.

10. Both greenhouse and field experiments have yielded results indicating that potassium salts may be beneficial in reducing wilt damage. Such fertilization methods appear to bring about delayed infection and the plant is able to mature a portion of its bolls, especially if such a system is combined with consistent rotation of crops so as to maintain the organic content of the soil.

11. A study of susceptible and wilt-resistant varieties of cotton has been made, and the behavior of these varieties on soil artificially inoculated with the fungus is described. It is suggested that preference be given to wilt-resistant cottons in tracts where the soil is heavily infested with the fungus. As a further measure of control of the disease, liberal fertilization of the crop is important and preference should be given to fertilizer formulas containing from 8 to 10 per cent phosphoric acid, 4 to 5 per cent potash, and from 4 to 6 per cent nitrogen.

Acknowledgments

In conclusion, the writer wishes to express his grateful appreciation to Dr. B. M. Duggar, under whose guidance the laboratory and greenhouse aspects of the problem have proceeded, and to thank him for the many suggestions and helpful criticisms which

he has given. He is also indebted to Dr. W. F. Hand, of the Department of Chemistry of the Mississippi A. & M. College, for the services he has rendered on many occasions as to certain chemical phases of the work. Acknowledgments are also due the National Fertilizer Association, who, through their appropriation of funds, made this investigation possible; to Mr. H. H. Wedgworth, of the Mississippi State Plant Board, who kindly made certain of the photographs and recorded wilt data at the Poplarville Branch Station; and to Dr. George T. Moore, for the privileges and facilities of the Missouri Botanical Garden.

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Explanation of Plate

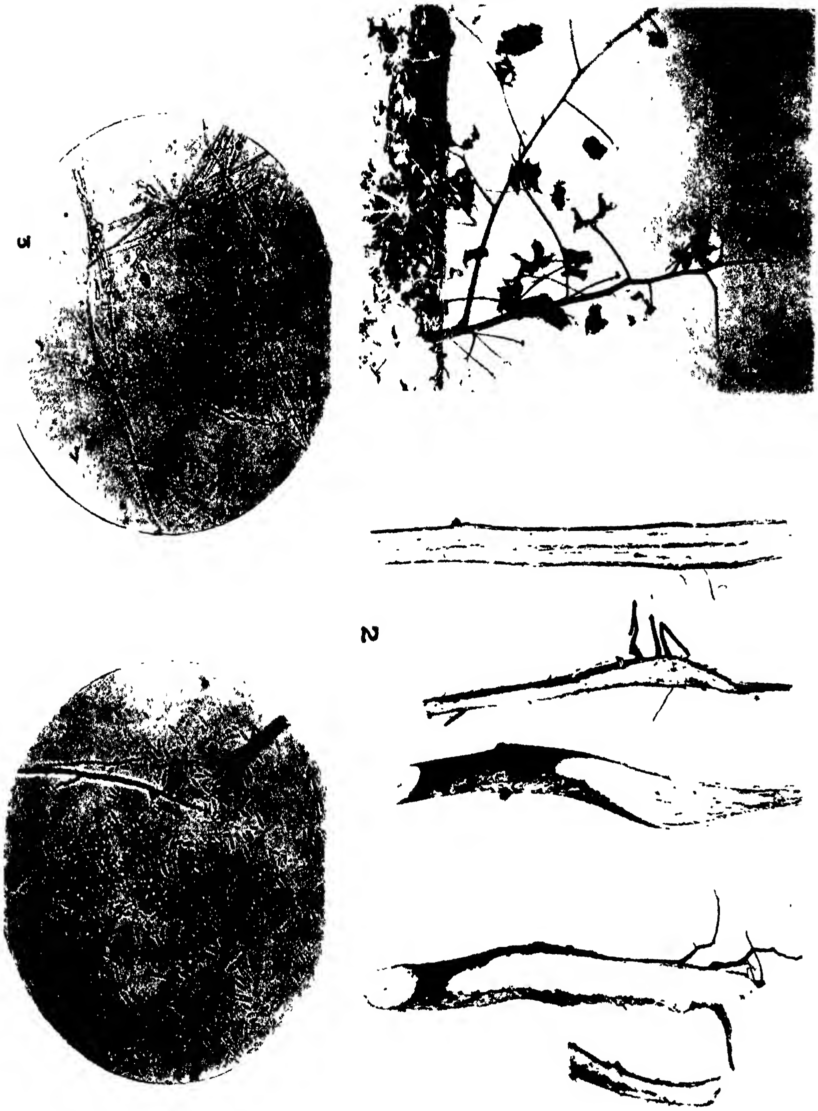
PLATE 31

Fig. 1. A cotton plant infected with the wilt fungus, *Fusarium vasinfectum*. Note that the main stem is short and stunted and the lower branch has grown normally.

Fig. 2. Stems of mature cotton plants sectioned to show the symptoms of the disease in the vascular elements. At left, three sections of stems from a diseased plant. Note the brown to black discoloration of the fibro-vascular tissues. At right, three sections from a healthy plant.

Fig. 3. Photomicrograph of *Fusarium vasinfectum* taken from a 12-day-old culture of the fungus growing on potato-dextrose agar showing terminal and intercalary formation of chlamydospores. $\times$ 100.

Fig. 4. Photomicrograph of *Fusarium vasinfectum* taken from a 10-day-old culture of the fungus growing on potato-dextrose agar showing micro- and macroconidia. $\times$ 100.



NEAL—COTTON WILT

Explanation of Plate

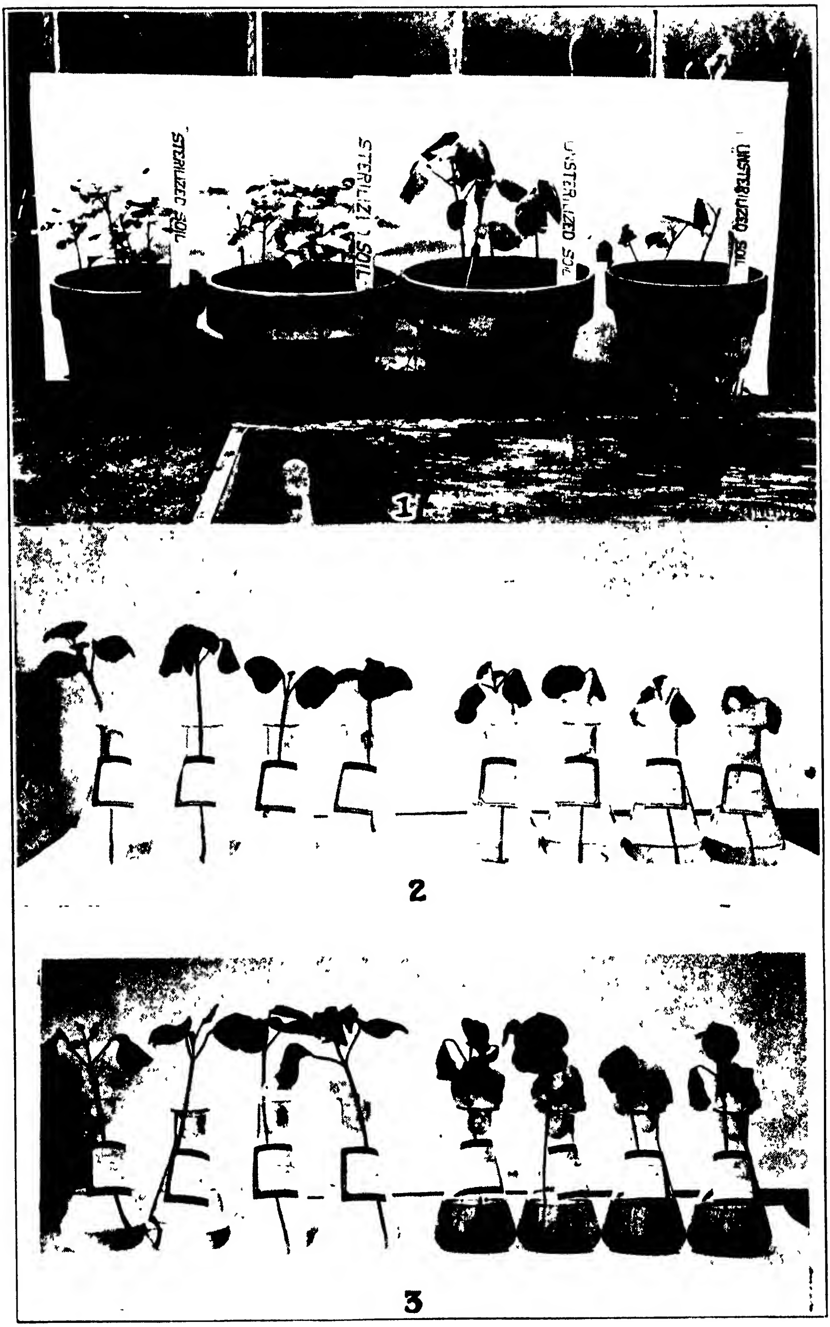
PLATE 32

Fig. 1. Experiments to determine the pathogenicity of cotton wilt, *Fusarium vasinfectum* Atk., in the greenhouse. Season 1926.

The soil in the above pots was heavily infested with the cotton wilt fungus, and was obtained from plot 1 in the cotton fertilizer experiments at the South Mississippi Experiment Station. The soil in the 2 pots at left was sterilized in autoclave for 5 hours prior to sowing seed. The soil in the 2 pots at right was unsterilized. The seed was planted September 15, 1926, and photographed December 3, 1926. Note the wilt in the unsterilized pots. Variety Delfos 6102.

Fig. 2. At left, uninoculated control flasks containing Duggar's solution and cotton seedlings. At right, cotton seedlings in flasks containing filtrates from 18-day cultures of *Fusarium vasinfectum* grown on Duggar's solution. Note toxic effect. All flasks photographed after treatment of 36 hours.

Fig. 3. At left, uninoculated control flasks containing sterile distilled water and cotton seedlings. At right, cotton seedlings in flasks containing extracts of mycelial mats from 18-day cultures of *Fusarium vasinfectum* grown on Duggar's solution. Note toxic effect. All flasks photographed after treatment of 36 hours.



NEAL—COTTON WILT

Explanation of Plate

PLATE 34

Variety of cotton in each series, Delfos 6102. All plants photographed after growing in inoculated sand cultures and receiving the nutrients indicated for approximately 7 months.

Fig. 1. Series I.
Fig. 2. Series II.
Fig. 3. Series III.
Fig. 4. Series IV.
Fig. 5. Series V.
Fig. 6. Series VI.

NEAL—COTTON WILT

Explanation of Plate

PLATE 35

Variety of cotton in each series, Delfos 6102. All plants photographed after growing in inoculated sand cultures and receiving nutrients indicated for approximately 7 months.

Fig. 1. Series VIII.
Fig. 2. Series IX.
Fig. 3. Series X.
Fig. 4. Series XI.
Fig. 5. Series XII.

NEAL—COTTON WILT

Explanation of Plate

PLATE 36

Fig. 1. Effect of commercial fertilizer upon the development of cotton wilt, *Fusarium vasinfectum*, in the greenhouse. Rate of application 800 pounds per acre. At top, plants uninoculated. At bottom, plants inoculated. Variety, Mississippi Station Trice. Season 1926.

Fig. 2. Cotton plants growing in a field in which fertilization has not been followed. Note the high per cent of wilt. Photographed September 8, at Mayhew, Mississippi. Season 1926.

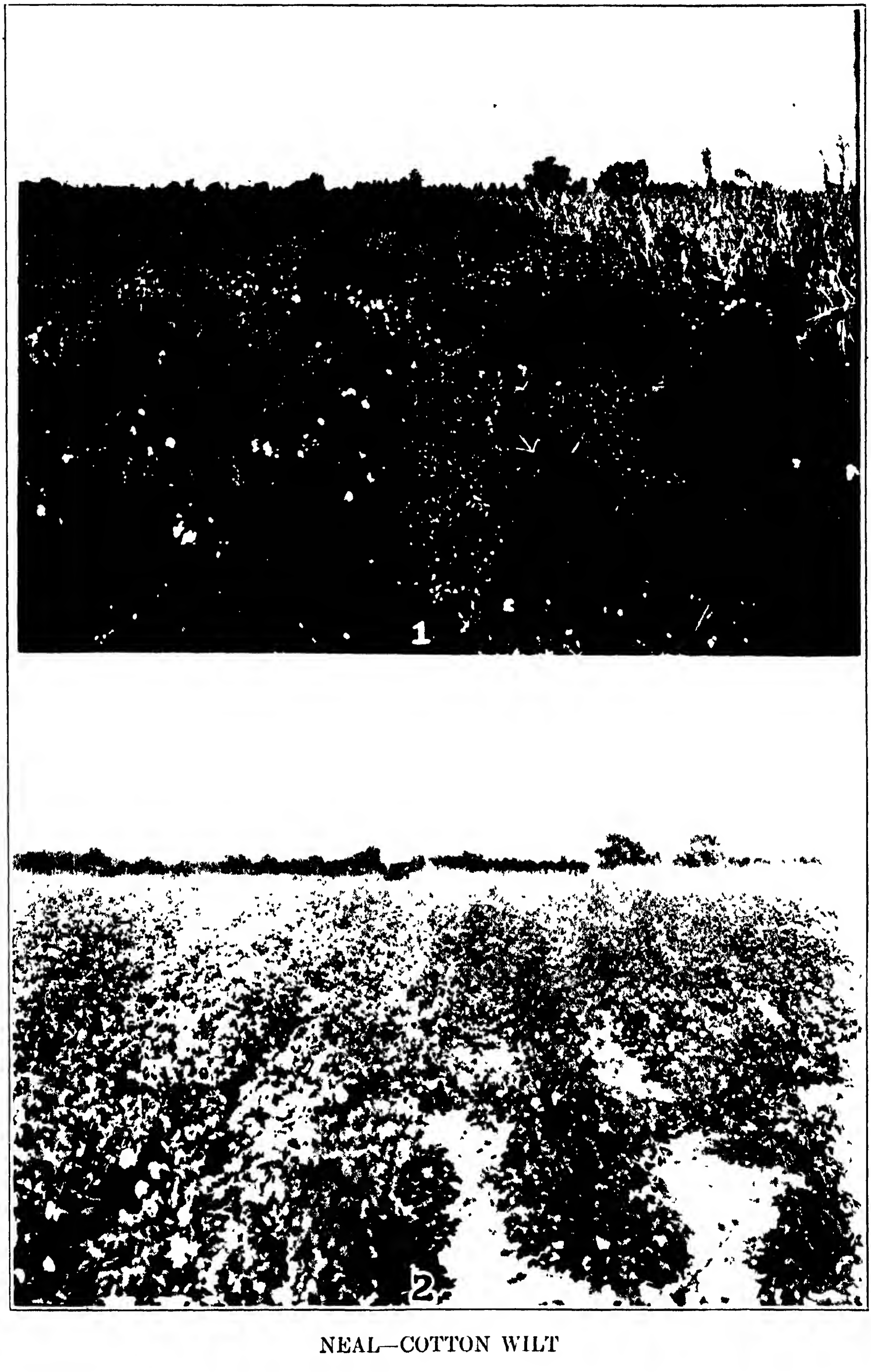
NEAL—COTTON WILT

Explanation of Plate

PLATE 37

Fig. 1. Cotton fertilizer experiments at South Mississippi Experiment Station, Poplarville. Plot 1, in the foreground, fertilized with 400 pounds acid phosphate and 150 pounds ammonium sulphate. Plot 4, in the background, fertilized with 400 pounds acid phosphate, 150 pounds ammonium sulphate, and 100 pounds potassium sulphate. Note the high per cent of wilt in plot 1. Season 1926.

Fig 2. Cotton fertilizer experiments at South Mississippi Experiment Station, Poplarville. At right, plot 5, check. At left, plot 6, 400 pounds acid phosphate, 150 pounds ammonium sulphate, and 150 pounds potassium sulphate. Season 1926.



NEAL—COTTON WILT

Explanation of Plate

PLATE 38

Fig. 1. Cotton fertilizer experiments at South Mississippi Experiment Station, Poplarville. At left, plot 12, fertilized with 400 pounds acid phosphate, 300 pounds ammonium sulphate, 250 pounds potassium sulphate. At right, check. Season 1926.

Fig. 2. A view of a cotton field near Aberdeen, Mississippi, showing the effect of a complete fertilizer on wilt control. The rows at left were not fertilized. The rows at right received 700 pounds per acre of an 8–4–4 fertilizer. Season 1926.

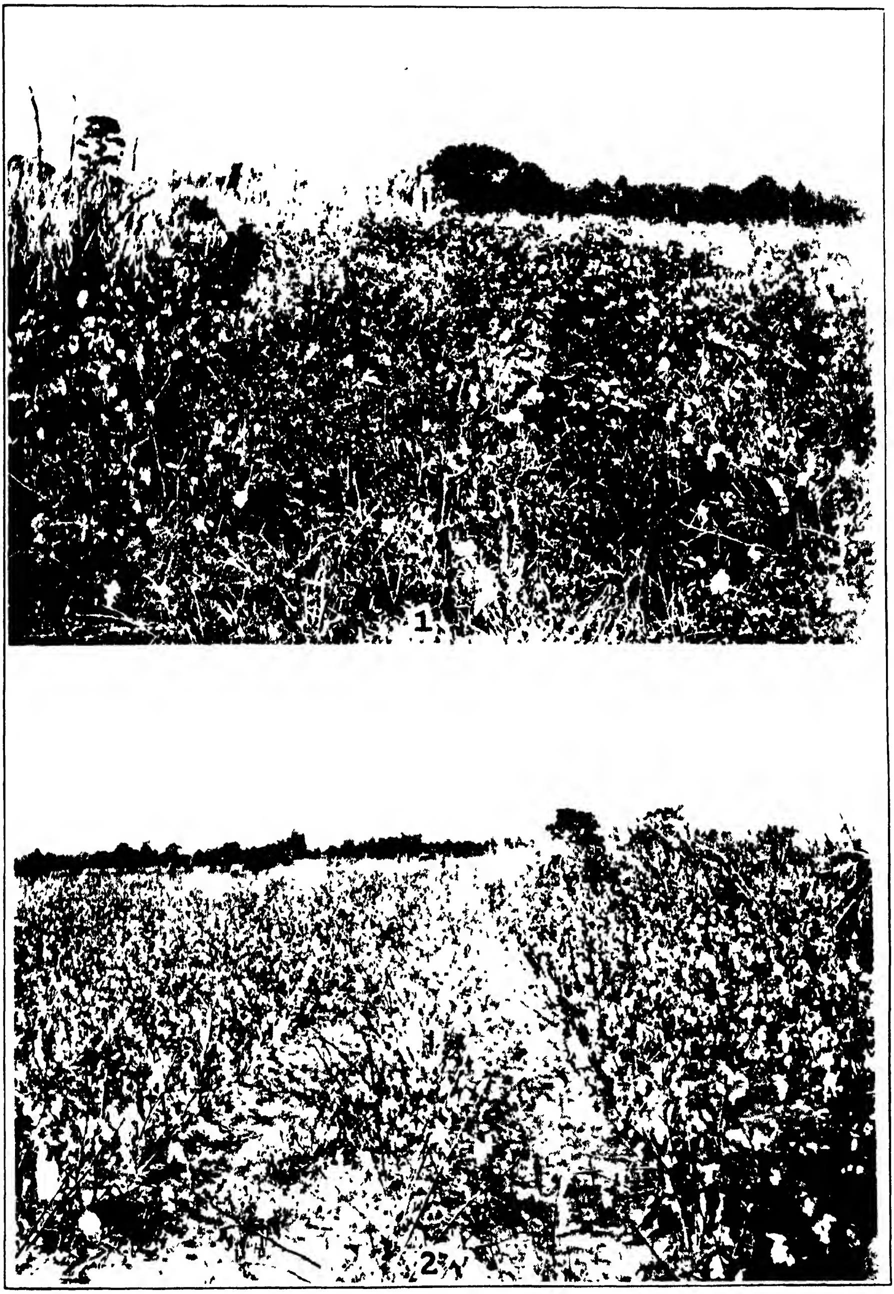
NEAL—COTTON WILT

Explanation of Plate

PLATE 39

Fig. 1. Cotton fertilizer experiments, South Mississippi Experiment Station, Poplarville. Plot 1, fertilized with 400 pounds acid phosphate and 150 pounds ammonium sulphate (referred to in plate 37, but photographed one month later when cotton was mature). Note missing hills and dead plants caused by the wilt fungus. Season 1926.

Fig. 2. Cotton fertilizer experiments, South Mississippi Experiment Station, Poplarville. Plot 4, referred to in plate 37 but photographed one month later when cotton was mature. Fertilized with 400 pounds acid phosphate, 150 pounds ammonium sulphate, and 100 pounds potassium sulphate. Note healthy appearance. Season 1926.



NEAL—COTTON WILT

SPECIES OF CERCOSPORA ON SMILAX IN THE UNITED STATES

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In the identification of a Missouri *Cercospora* on *Smilax* leaves it was found desirable to examine rather critically authentic material of the different species reported on that host. These species are as follows: *C. Smilacis* de Thuem; *C. Smilacina* Sacc.; *C. Petersii* (Berk. & Curt.) Atk.; *C. mississippiensis* Tracy & Earle; *C. subsanguinea* Ell. & Ev.; and *C. nubilosa* Ell. & Ev. Of these, *C. nubilosa* can be left out of the subsequent discussion, since an examination of the type collection in the herbarium of the Missouri Botanical Garden shows that it is on leaves of *Dioscorea villosa* L. and not on *Smilax* as originally reported. On the original label the host is recorded as "Smilax ?," but the doubt indicated by the question mark was not incorporated in the record when the species was described. However, comparisons of the leaves with those of *Dioscorea villosa* L. shows conclusively that they are from plants of the latter species.

C. subsanguinea has been available only from one collection, on *Maianthemum canadense*, distributed in 'Fungi Columbiana,' No. 4110. On this host it forms irregular necrotic areas 1 cm. or more broad and long, not bordered by a distinct margin. This is in sharp contrast to the type of spot produced by the other species on *Smilax*. The fasciculate conidiophores are abundant on the lower side of the leaf over all the dead area. They measure 40–240 × 6 μ. The spores also are distinctive, being practically cylindric, 10-celled or more when mature, and measure 45–120 × 5–6 μ. If these are the characters of that species when on *Smilax* as well, it need not be confused with the species discussed below.

The other collections examined, numbering in all about thirty, readily fall into two groups on the basis of size and shape of the spores. Before describing these in detail it may be well to state that an examination of this series of collections has demonstrated

conclusively that one can easily be misled by failing to recognize the variability in the shape and coloration of the conidiophores in young and old specimens. Probably in all species of *Cercospora* the conidiophores are at first straight and pale-colored (pl. 41, fig. 4), i.e., pale fuscous or pale cinnamon. The conidia originate apically, and one may find an entire collection in which the conidiophores and the conidia are in this stage of development. If the fungus continues growth, however, the apical conidium is pushed aside as the conidiophore grows distally from a point near the point of origin of the first conidium. This manner of growth forms an offset in the conidiophore hypha at that point. Another conidium is produced on the apex of the new growth, and it in turn may be pushed aside and another offset results. As a result of this method of growth an old conidiophore may become very irregular at its apex. At times the direction of growth assumed by the conidiophore after the production of one conidium may be almost at right angles to that of its previous growth, in consequence of which the mature conidiophore may present a sharp elbow near its distal end (pl. 41, fig. 7). Likewise the color of the conidiophore becomes darker with age, so that while in a young condition it may appear rather pale, in an older stage it assumes a darker color, in the species discussed here becoming dark reddish-brown or chestnut on the lower part, the apex remaining somewhat paler.

Length of the conidiophores is also a factor on which little reliance can be placed in the genus if the conditions in the species on *Smilax* can be taken as a criterion. For example, in a collection distributed by Nash in 'Plants of Florida,' No. 1872, the conidiophores measure 40–75 μ long, and essentially the same measurements are obtained from de Thuemen, 'Myc. Univ.' No. 1670. However, in Nash, 'Plants of Florida,' No. 1893, they measure 45–135 μ and in a collection by Peck at Manor, L. I. (Herb. N. Y. State Mus.) they measure 72–225 μ. Yet in other characters these three collections are so similar that there can be no doubt they should be referred to the same species. Likewise a collection by Peck at Wading River, N. Y., gives conidiophores 50–140 μ, while one at Arcadia, Mo. (Overholts Herb. 10426) has them 75–210 μ; in 'Plants of the Gulf States,' No. 7802, they

are 150–180 μ long; and in Nash, 'Plants of Florida,' No. 2125, they are 105–165 μ. Moreover, I have found that mounts from different spots on the same leaf give about as much variation as may be exhibited by different collections, so that it has become quite evident that, in the species on *Smilax* at least, little reliance can be placed on the length of the conidiophores.

After examining all the available collections it is apparent, as stated above, that they readily fall into two categories on the shape and size of the spores, so that of the four described species yet to be considered, two only can remain as valid. One of these is *C. Smilacis* de Thuemen, in which the conidia are subcylindric, tapering very gradually to a narrowed apex, and hence in reality slightly obclavate when seen on the conidiophores. Frequently they are considerably curved. They measure for the most part 60–135 × 4–5 μ, but some as short as 40–50 μ are to be found, and perhaps longer ones also could be located. The septations are most frequently only two or three in number but may vary to ten or eleven, or perhaps more (see pl. 40).

The other collections must be referred to *C. Smilacina*. American specimens were first so identified by Saccardo, the material being the same collection that de Thuemen had apparently referred for Peck to his own *C. Smilacis*. Since Peck reported it as this species (Ann. Rept. N. Y. State Mus. **33**: 29. 1880) it is sometimes cited in synonymy as *C. Smilacis* Peck. The species differs from *C. Smilacis* in the conidia that are usually rather abruptly narrowed at one end and have a tendency to be snowshoe-shaped or the shape of a tailed pumpkin seed. Most of the conidia measure 40–65 × 5–6 μ, but a few are as short as 30 μ and 4–5 μ in diameter, while occasionally a spore as much as 75 μ long has been seen. They may be as much as 8-celled, but usually show less than that number. In general, therefore, they are much shorter than those of *C. Smilacis* and are more sharply contracted at one end (see pl. 41).

How often it occurs that *Cercospora* conidia are clavate and not obclavate on the conidiophores, remains for further study to determine. As originally founded by Fresenius ('Beitrage zur Mykologie,' p. 91, 1863) the genus is based on *C. Apii*, which he illustrates as with obclavate conidia, and the usual conception

of the genus involves that characteristic. While I have not seen a large number of clavate spores on conidiophores in *C. Smilacina*, yet they have been observed several times, though always obviously immature, and at a later stage of maturity they may possibly take a more obclavate form.

I find nothing in the character of the spots produced by these two species to aid in their macroscopic separation. They vary to a considerable extent on the different hosts, with variation in thickness and texture of the leaves. Always the spots produced by both species are subcircular in form and at first dark in color, the center usually becoming lighter in color with age, leaving a narrow, dark red or purplish, often raised margin. Yet in some collections the margin is not well marked. The conidiophores are usually hypophyllous in both species, but at times are amphigenous, though this tendency to occur on both surfaces seems more marked in *C. Smilacis* than in *C. Smilacina*.

A few words may be said regarding *C. Petersii*. The species was originally described as a *Helminthosporium* (Grevillea **3**: 102. 1875), but was transferred to *Cercospora* by Atkinson (Jour. Elisha Mitchell Scientif. Soc. **8**: 25. 1892). I have examined mounts from the type collection of this species but failed to find the conidia and found only a few conidiophores, and was not able to arrive at any decision as to the exact status of the species. In the sense of Atkinson (*l.c.*) and as determined in several collections by Ellis it most certainly is *C. Smilacina*, and I am of the opinion that it must be regarded as a synonym of that name. It is recorded in Saccardo's host index as on the stems of *Smilax*, evidently an error, since the original description specifically locates it on the lower surface of the leaves of *Smilax* and of *Laurus*.

The following diagnoses of the two species most concerned in this treatise are appended:

Cercospora Smilacis de Thuemen, Myc. Univ. No. 1670. 1880. Pl. 40.

C. mississippiensis Tracy & Earle, Bull. Torr. Bot. Club **22**: 179. 1885.

Spots subcircular, usually limited by the veins, 1–7 mm. in diameter, at first dark purplish red, then becoming paler at the

center while retaining a dark conspicuous margin; conidiophores fasciculate, hypophyllous or amphigenous, septate, pale cinnamon to fuscous or chestnut, at first straight and paler at the tips, in age becoming chestnut color and the tips nodulose or wavy, 45–225 μ long, 3–5 μ broad; conidia subcylindric, gradually narrowed at the apex, hence somewhat obclavate, 3–4-celled or becoming 10- to 14-celled, pale fuscous, 60–135 × 4–5 μ.

On living leaves of various species of *Smilax*.

The species differs from *C. Smilacina* Sacc. in the longer spores that are sub-cylindric and not sharply narrowed.

Specimens examined: de Thuemen, Myc. Univ. Nos. 1670 (type) and 1768; Starkville, Miss., 1891, *Tracy* (type of *C. mississippiensis* Tracy & Earle) (Mo. Bot. Gard. Herb. and Herb. N. Y. State Mus.); Manor, L.I., *Peck* (Herb. N. Y. State Mus.); Columbus, Miss., 1895, *Tracy* (Mo. Bot. Gard. Herb.); Nash, Plants of Florida, Nos. 1893, 1872, and 2073 (Mo. Bot. Gard. Herb.); Ellis, N. Am. Fungi, No. 1251 (Mo. Bot. Gard. Herb.); Bairds, Miss., *Tracy* (Mo. Bot. Gard. Herb.).

Cercospora Smilacina Sacc. Michelia **2**: 364. 1881. Pl. 41.

? C. Petersii (Berk. & Curt.) Atk. Jour. Elisha Mitchell Scientif. Soc. **8**: 25. 1892.

? Helminthosporium Petersii Berk. & Curt. Grevillea **3**: 102. 1875.

Spots subcircular, usually limited by the veins, 1.5–5 mm. in diameter, at first uniform dark red or purplish black, becoming paler at the center as the spot expands, retaining (usually) a dark, somewhat raised border; conidiophores hypophyllous or rarely amphigenous, fasciculate, septate, pale cinnamon to chestnut below, usually paler above and there quite wavy or nodulose in extreme age, sometimes bent almost at right angles near the upper end, 50–215 μ long; conidia terminal and lateral, rather abruptly narrowed toward one end, pale fuscous to brownish, usually 2- to 4-celled, sometimes 6- to 8-celled, 40–65(–75) × 6 μ.

On living leaves of various species of *Smilax*.

The species is easily separated from *C. Smilacis* by the conidia that are rather abruptly narrowed near the middle, and less than 75 μ long.

Specimens examined: Wading River, N. Y., 1879, *Peck* (Herb. N. Y. State Mus.); Shelter Island, N. Y., *Clinton* (Herb. N. Y. State Mus.); Plainville, Conn., 1883, *A. B. Seymour* (Mo. Bot. Gard. Herb.); Ravenel, Fungi Am. Nos. 166 and 616 (Mo. Bot. Gard. Herb.); Hume, Florida Fungi, No. 62 (Mo. Bot. Gard. Herb. and Herb. N. Y. State Mus.); Tracy, Plants of the Gulf States, No. 7802, Auburn, Ala., 1897 (Mo. Bot. Gard. Herb.); Auburn, Ala., 1896, *Underwood* (Mo. Bot. Gard. Herb.); Nash, Plants of Florida, No. 2125 (Mo. Bot. Gard. Herb.); Seymour & Earle, Economic Fungi, No. 199 (Mo. Bot. Gard. Herb.); Bartholomew, Fungi Col. No. 2808 (Mo. Bot. Gard. Herb.); Arcadia, Mo., 1926 (Overholts Herb., No. 10426, and Mo. Bot. Gard. Herb.).

Explanation of Plate

PLATE 40

Cercospora Smilacis

Fig. 1. Conidia from de Thuemen, Myc. Univ. 1768. × 400.

Fig. 2. Fascicle of conidiophores emerging through a stoma. Ellis, N. Am. Fungi, 1251. × 160.

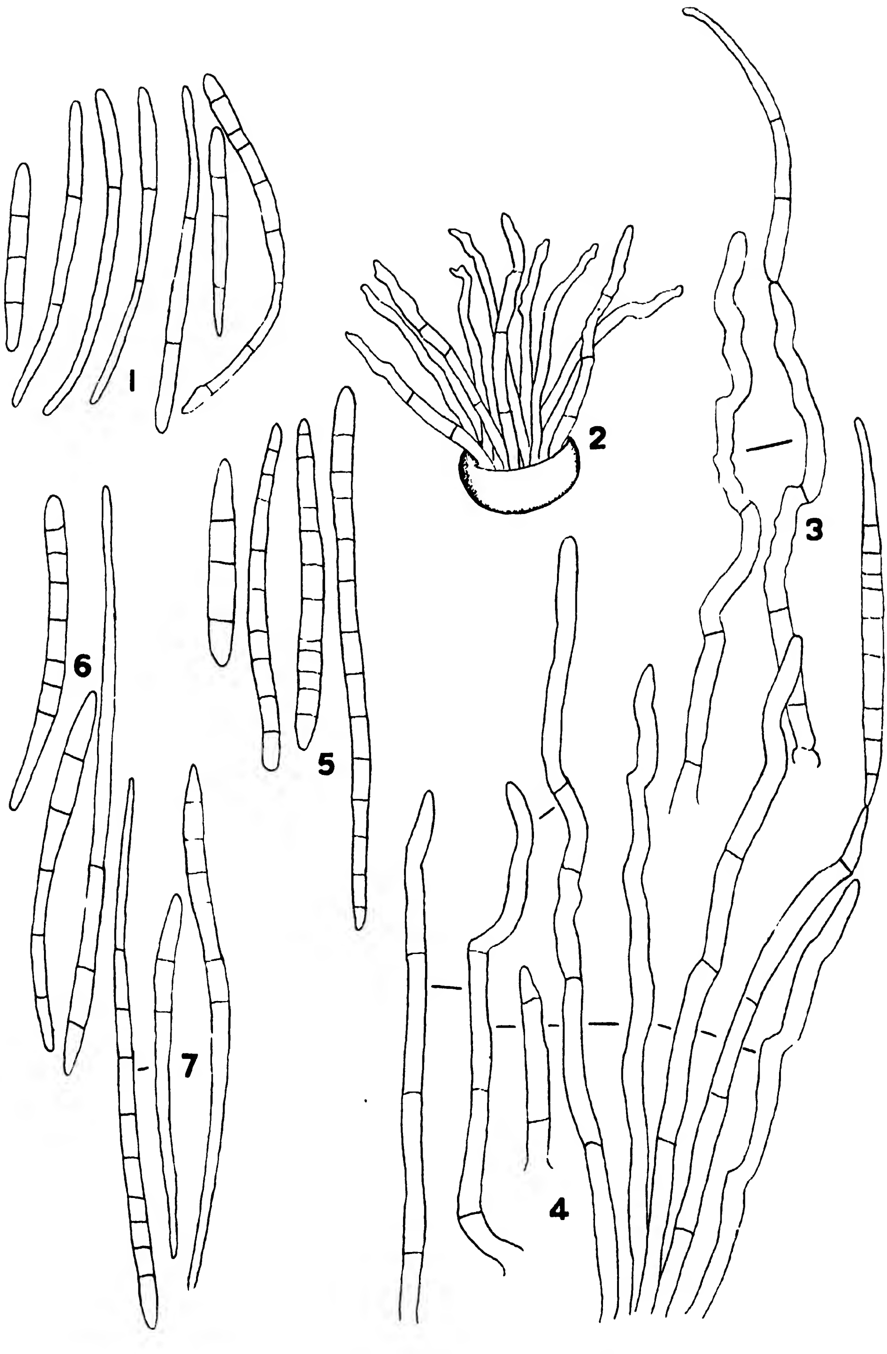
Fig. 3. Conidiophores, one bearing an obclavate conidium. From de Thuemen, Myc. Univ. 1768. × 400.

Fig. 4. Conidiophores, one bearing a conidium. From deThuemen, Myc. Univ. 1670. × 400.

Fig. 5. Conidia. From Ellis, N. Am. Fungi, No. 1251. × 400.

Fig. 6. Conidia. From the type collection of *C. mississippiensis*. × 400.

Fig. 7. Conidia. From collection at Starkville, Miss., by Tracy, 1892. × 400.



OVERHOLTS CERCOSPORA ON SMILAX

Explanation of Plate

PLATE 41

Cercospora Smilacina

Fig. 1. Conidia. From Tracy, Plants of the Gulf States, No. 7802. × 420.

Fig. 2. Conidia. From collection at Arcadia, Mo., 1926, Overholts Herb. 10426. × 420.

Fig. 3. Conidia. From Seymour & Earle, Economic Fungi, No. 199. × 420.

Fig. 4. Conidiophores in young condition. From collection at Auburn, Ala., 1896. × 420.

Fig. 5. Conidia. Same as fig. 4.

Fig. 6. Conidia and two conidiophores. From Bartholomew, Fungi Col. 2808. × 420.

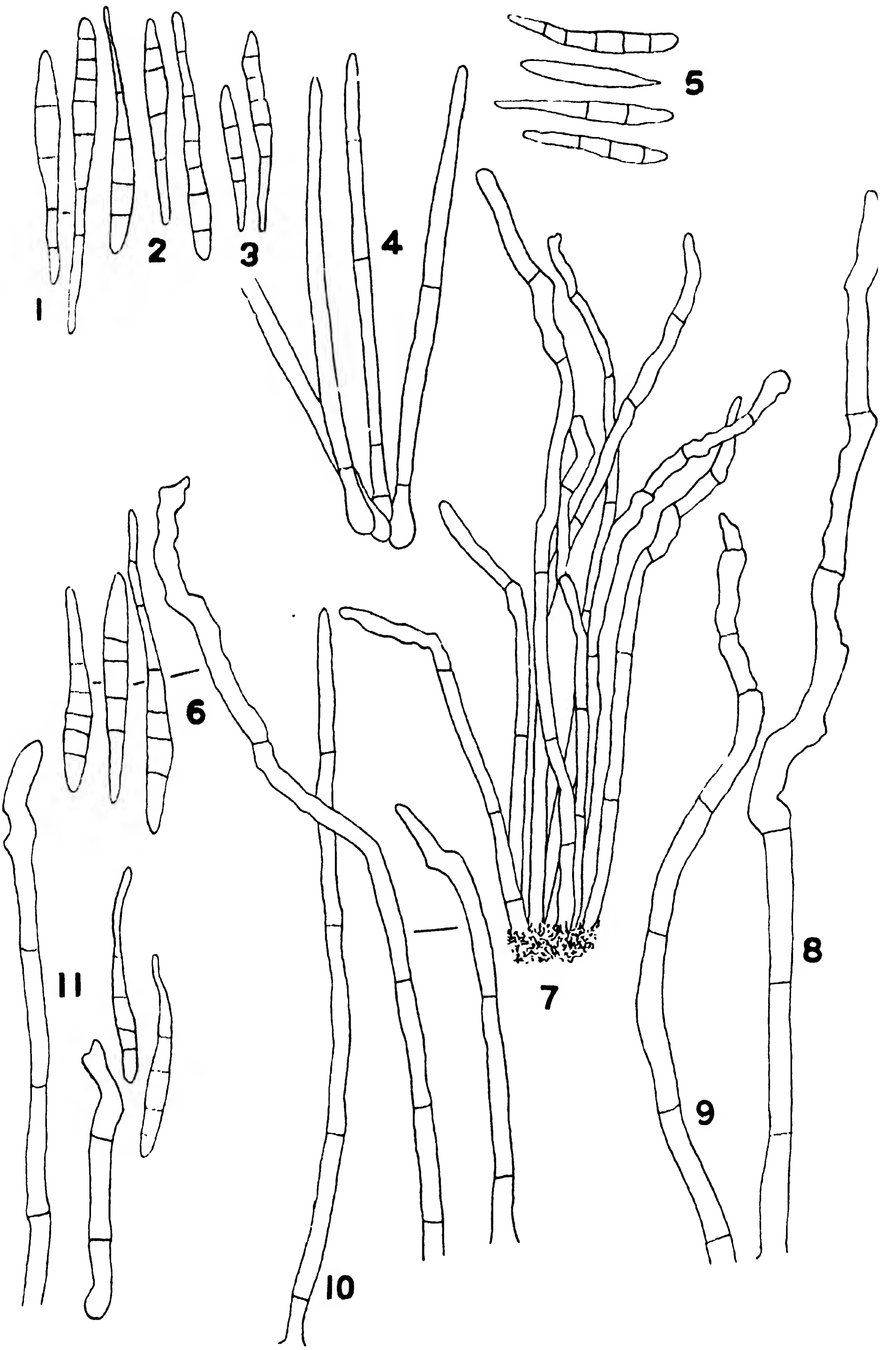
Fig. 7. Fascicle of conidiophores. From collection at Arcadia, Mo., 1926, Overholts Herb. 10426. × 165.

Fig. 8. Old conidiophore. Same as fig. 7. × 420.

Fig. 9. Old conidiophore. From Seymour & Earle, Economic Fungi, No. 199. × 420.

Fig. 10. Conidiophore. From Tracy, Plants of the Gulf States, No. 7802. × 420.

Fig. 11. Two conidiophores and two conidia. From collection at Wading River, N .Y., Peck, 1879. × 420.



OVERHOLTS - CERCOSPORA ON SMILAX

GENERAL INDEX TO VOLUME XIV

New scientific names of plants and the final members of new combinations are printed in **bold face** type; synonyms and page numbers having reference to figures and plates, in *italics;* and previously published scientific names and all other matter, in ordinary type.

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